ANL/CFCT-21/28

Data Package of Results from Salt Spill Testing

Chemical and Fuel Cycle Technologies Division, Argonne National Laboratory

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Acronyms

EDS	Energy dispersive X-ray spectroscopy
FLiNaK	LiF-NaF-KF eutectic (46.5-11.5-42 mol %)
ICP-MS	Inductively coupled plasma-mass spectrometry
ICP-OES	Inductively coupled plasma-optical emission spectroscopy
IR	Infrared
MSR	Molten salt reactor
PD	Potentiodynamic
PS	Potentiostatic
PTFE	Poly(tetrafluoroethylene)
SEM	Scanning electron microscopy

Abstract

This document provides or identifies the full suite of data that was measured in laboratory salt spill tests on molten salt spreading and heat transfer, molten salt flowing and freezing in tubing, stainless steel corrosion kinetics in molten salt, and molten salt splashing and aerosol generation. The background, motivation, and methods for the work are explained in detail in an accompanying report (Thomas and Jackson, 2021), which includes representative results for all measurements. Quantitative data are tabulated to facilitate use in follow-on calculations and qualitative data in the form of visual and infrared video files are indexed for reference.

1 Introduction

This document provides the full suite of data that were measured in laboratory tests to provide experimental data that can be used to parameterize and validate individual process models that predict the consequences of molten salt spill accidents. All tests were conducted with pure eutectic FLiNaK (46.5-11.5-42 mol % LiF-NaF-KF) or eutectic FLiNaK doped with 0.9 mol % CsF and 0.099 mol % CsI as surrogate fission products. The motivation for the work, the experimental approach, the experimental designs, and the methods are described in detail elsewhere (Thomas and Jackson, 2021). The results provided in this document are grouped in sections that focus on four aspects of a molten salt spill accident:

- Molten salt spreading and heat transfer on stainless steel sheets,
- Molten salt flowing and freezing in stainless steel tubing,
- Stainless steel corrosion kinetics in molten salt, and
- Molten salt splashing and aerosol generation.

The corresponding sections addressing these aspects of a molten salt spill accident in Thomas and Jackson, 2021 are identifed for convenience. Representative results are provided in Thomas and Jackson, 2021 and most of the acquired data are provided in this document. Datasets that are too large for inclusion in this document and available videos are identified in the following sections and can be provided by the authors upon reasonable request.

2 Molten salt spreading and heat transfer

The data provided in this section correspond to Section 3 in Thomas and Jackson, 2021, and the experimental design and methods are described therein. Table 1 provides a summary of the conditions used in each FLiNaK spreading and heat transfer test that was conducted.

Table 1: Summary of spreading and heat transfer test conditions

Test	Target initial salt temp. (°C)[a]	Max temp. (°C)[b]	Mass of salt poured (g)	Average pour rate (g s^{-1})	Sheet tilt angle (°)	CsF & CsI in salt?
1	500	476.7	28.4	20.8	2.5	No
2	500	494.5	38.4	21.8	5.0	No
3	550	530.0	49.0	18.6	2.5	No
4	650	625.3	30.0	19.6	2.5	Yes[c]
5	650	640.0	24.3	13.3	5.0	No
6	650	649.0	29.6	22.2	2.5	No
7	800	731.5	19.1	9.7	5.0	No
8	800	734.1	30.3	13.6	2.5	No
9	800	794.5	30.6	29.6	2.5	No

[a] The actual salt temperature may have differed from the target temperature.
[b] The maximum temperature of the salt measured by the infrared camera (uncorrected for emissivity) provides an estimate of the actual salt temperature as it was poured.
[c] Added 0.200 g CsI and 0.967 g CsF to FLiNaK with a total mass of 30.463 g.

2.1 Visible video from tests of molten salt spreading and freezing on a stainless steel substrate

Video of the molten salt spreading and freezing on the stainless steel substrate was filmed using a visible camera mounted on a tripod and is available upon reasonable request. A list of available videos is provided in Table 2.

Table 2: List of available visible video of spreading tests

Test	Filename	Notes
1	SpreadingVideo_Test1.mp4	Video is blurry
2	SpreadingVideo_Test2.mp4	–
3	SpreadingVideo_Test3.mp4	–
4	SpreadingVideo_Test4.mp4	–
5	SpreadingVideo_Test5.mp4	–
6	SpreadingVideo_Test6.mp4	–
7	SpreadingVideo_Test7.mp4	Video taken using camera outside of glovebox
8	SpreadingVideo_Test8.mp4	–
9	SpreadingVideo_Test9.mp4	–

2.2 Temperature of substrate underside measured by thermocouple

The temperatures at the underside of the substrate surface were measured by using butt-welded thermocouple lead wires with the junction attached to the surface with thermally conductive cement. A description of the method and the performance of the method is provided in Appendix B of Thomas and Jackson, 2021.

Figure 1 shows the layout of the thermocouples attached to the underside of the stainless steel substrate overlaid on a still frame of video collected by using the infrared (IR) camera for Tests 1, 3, 4, 6, 8, and 9. These images show the positions of the salt after spreading ceased relative to the locations of the thermocouples. The pooled salt at the end of the substrate for Test 4 is blocked from the field of view of the IR camera by a platinum foil (Figure 3C). The thermocouple measurements failed for Tests 2, 5, and 7 and the temperature of the underside of the substrate is unknown for these tests. The position of Thermocouple 8 (TC8) was approximately 0.5 in. from the bottom of the sheet for all tests.

The temperatures recorded by each thermocouple for Tests 1, 3, 4, 6, 8, and 9 are provided in Table 3, Table 4, Table 5, Table 6, Table 7, and Table 8, respectively.

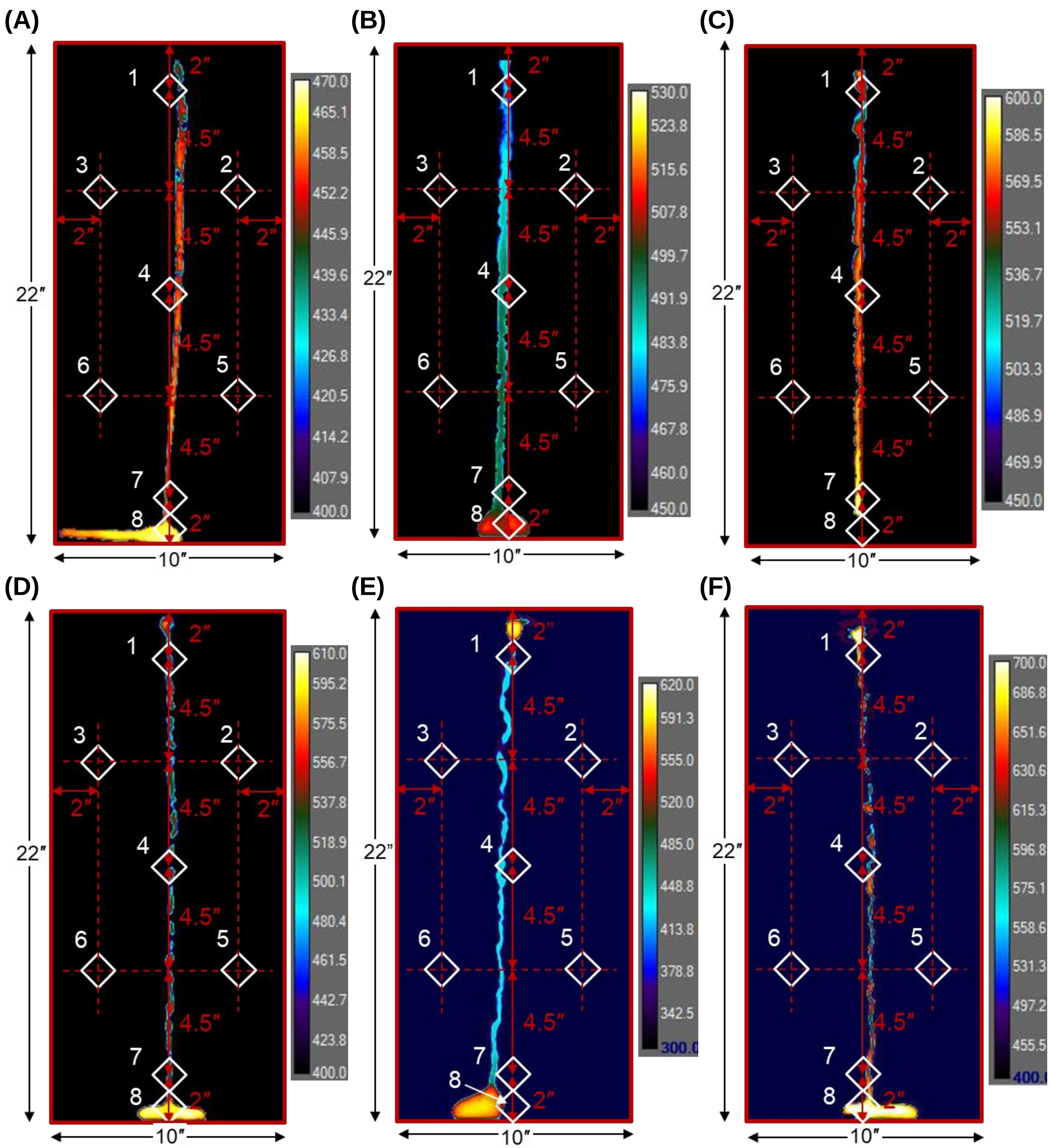

Figure 1: Location of thermocouples attached to the underside of the substrate overlaid on an image of the salt spreading path for Tests (A) 1, (B) 3, (C) 4, (D) 6, (E) 8, and (F) 9. Thermocouple 8 is positioned approximately 0.5 in. from the substrate bottom. A platinum foil blocked the pooled salt above Thermocouple 8 from the IR camera field of view for Test 4 in subplot C.

Table 3: Temp. (°C) measured by thermocouples attached to substrate underside for Test 1

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
0.00	27.0	26.9	27.8	28.7	26.7	27.2	25.3	26.4
0.25	55.2	26.9	27.8	48.8	26.7	27.2	44.2	125.3
0.50	58.3	27.0	27.8	57.7	26.7	27.2	60.5	154.3
0.75	60.5	27.0	27.9	60.3	26.8	27.2	70.9	153.9
1.00	61.0	27.0	27.9	61.0	26.8	27.3	76.1	149.3
1.25	60.5	27.1	28.1	61.0	26.9	27.3	78.5	145.0
1.50	59.3	27.1	28.2	60.7	27.0	27.4	79.5	140.9
1.75	59.7	27.3	28.4	60.0	27.2	27.5	79.7	137.0
2.00	60.3	27.4	28.7	59.3	27.4	27.7	79.6	133.2
2.25	59.6	27.7	29.0	58.5	27.7	28.0	79.1	129.4
2.50	58.4	27.9	29.4	57.7	28.0	28.2	78.4	125.6
2.75	57.1	28.2	29.8	56.9	28.4	28.5	77.6	121.9
3.00	55.7	28.5	30.3	56.1	28.7	28.8	76.7	118.1
3.25	54.3	28.8	30.7	55.2	29.1	29.2	75.8	114.6
3.50	52.8	29.1	31.1	54.3	29.4	29.5	74.7	111.4
3.75	51.4	29.4	31.5	53.5	29.7	29.8	73.7	108.1
4.00	50.1	29.7	31.9	52.6	30.1	30.1	72.6	104.9
4.25	48.8	30.0	32.3	51.8	30.4	30.4	71.5	101.9
4.50	47.7	30.3	32.7	51.0	30.6	30.6	70.4	98.9
4.75	46.6	30.6	33.0	50.2	30.9	30.9	69.3	96.0
5.00	45.6	30.8	33.3	49.5	31.1	31.1	68.2	93.2
5.25	44.7	31.0	33.5	48.8	31.4	31.3	67.1	90.5
5.50	43.8	31.1	33.7	48.1	31.5	31.5	66.0	88.0
5.75	43.0	31.3	33.9	47.4	31.7	31.7	64.9	85.6
6.00	42.2	31.5	34.1	46.8	31.9	31.8	63.8	83.3
6.25	41.5	31.6	34.3	46.2	32.1	31.9	62.7	81.0
6.50	40.9	31.7	34.4	45.6	32.2	32.0	61.6	78.9
6.75	40.3	31.8	34.5	45.1	32.3	32.0	60.6	76.9
7.00	39.7	31.8	34.6	44.6	32.5	32.1	59.6	75.0
7.25	39.2	31.9	34.6	44.1	32.5	32.1	58.5	73.1
7.50	38.7	31.9	34.7	43.6	32.6	32.2	57.6	71.3
7.75	38.2	32.0	34.7	43.1	32.7	32.2	56.6	69.6
8.00	37.7	32.0	34.7	42.7	32.8	32.2	55.7	67.9
8.25	37.3	32.0	34.7	42.2	32.8	32.2	54.8	66.4
8.50	36.9	32.0	34.7	41.8	32.9	32.2	53.9	64.9
8.75	36.5	32.0	34.7	41.4	32.9	32.2	53.1	63.5
9.00	36.2	31.9	34.7	41.0	33.0	32.2	52.3	62.1
9.25	35.8	31.9	34.6	40.7	33.0	32.2	51.5	60.8
9.50	35.5	31.9	34.6	40.4	33.0	32.2	50.6	59.6
9.75	35.2	31.9	34.6	40.0	33.0	32.1	49.9	58.2
10.00	34.9	31.8	34.5	39.7	33.0	32.1	49.1	56.9

Table 3: (cont.)

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
10.25	34.7	31.8	34.4	39.4	33.0	32.0	48.4	55.7
10.50	34.4	31.8	34.4	39.1	33.0	32.0	47.7	54.5
10.75	34.2	31.7	34.3	38.8	33.0	32.0	47.0	53.4
11.00	33.9	31.7	34.2	38.6	33.0	31.9	46.4	52.4
11.25	33.7	31.6	34.2	38.3	33.0	31.9	45.8	51.5
11.50	33.5	31.5	34.1	38.1	33.0	31.8	45.1	50.6
11.75	33.2	31.5	34.0	37.8	32.9	31.8	44.5	49.7
12.00	33.0	31.4	33.9	37.6	32.9	31.8	43.9	48.9
12.25	32.9	31.4	33.9	37.4	32.9	31.7	43.4	48.1
12.50	32.7	31.3	33.8	37.1	32.8	31.7	42.8	47.3
12.75	32.5	31.3	33.7	36.9	32.8	31.6	42.3	46.6
13.00	32.3	31.2	33.6	36.7	32.8	31.5	41.8	45.8
13.25	32.2	31.2	33.5	36.5	32.7	31.5	41.3	45.2
13.50	32.0	31.1	33.4	36.3	32.7	31.5	40.8	44.5
13.75	31.9	31.0	33.4	36.2	32.6	31.4	40.4	43.9
14.00	31.7	31.0	33.3	36.0	32.6	31.4	39.9	43.3
14.25	31.6	30.9	33.2	35.8	32.5	31.3	39.5	42.8
14.50	31.5	30.9	33.1	35.7	32.5	31.3	39.1	42.2
14.75	31.4	30.8	33.0	35.5	32.4	31.2	38.7	41.7
15.00	31.3	30.8	32.9	35.4	32.4	31.2	38.3	41.2
15.25	31.1	30.7	32.8	35.2	32.3	31.1	37.9	40.8
15.50	31.0	30.7	32.8	35.1	32.2	31.1	37.6	40.3
15.75	30.9	30.6	32.7	34.9	32.2	31.0	37.2	39.9
16.00	30.8	30.6	32.6	34.8	32.1	31.0	36.9	39.5
16.25	30.7	30.5	32.5	34.6	32.0	30.9	36.6	39.1
16.50	30.6	30.5	32.4	34.5	32.0	30.9	36.2	38.7
16.75	30.6	30.4	32.4	34.4	31.9	30.8	35.9	38.3
17.00	30.5	30.4	32.3	34.3	31.9	30.8	35.6	37.9
17.25	30.4	30.3	32.2	34.2	31.8	30.7	35.4	37.6
17.50	30.3	30.3	32.2	34.0	31.7	30.7	35.1	37.3
17.75	30.2	30.3	32.0	33.9	31.7	30.6	34.8	37.0
18.00	30.2	30.2	32.0	33.8	31.6	30.6	34.6	36.7
18.25	30.1	30.2	31.9	33.7	31.6	30.5	34.3	36.4
18.50	30.0	30.1	31.8	33.6	31.5	30.5	34.1	36.1
18.75	30.0	30.1	31.8	33.5	31.4	30.4	33.9	35.8
19.00	29.9	30.0	31.7	33.4	31.4	30.4	33.6	35.5
19.25	29.8	30.0	31.6	33.3	31.3	30.4	33.4	35.3
19.50	29.8	29.9	31.6	33.2	31.2	30.3	33.2	35.0
19.75	29.7	29.9	31.5	33.1	31.2	30.3	33.0	34.8
20.00	29.6	29.8	31.5	33.0	31.1	30.2	32.8	34.6

Table 4: Temp. (°C) measured by thermocouples attached to substrate underside for Test 3

Time (min.)	TC1	TC2[a]	TC3	TC4[a]	TC5	TC6	TC7	TC8
0.00	25.9	–	26.8	–	25.4	26.3	24.0	25.2
0.25	100.8	–	26.8	–	25.4	26.3	24.1	44.9
0.50	115.8	–	26.9	–	25.5	26.3	41.8	133.4
0.75	114.2	–	26.9	–	25.5	26.3	78.2	198.2
1.00	109.3	–	27.1	–	25.5	26.5	111.4	230.3
1.25	103.9	–	27.5	–	25.6	27.0	127.8	229.2
1.50	103.2	–	28.2	–	25.7	27.7	139.1	216.9
1.75	102.1	–	29.1	–	25.8	28.5	147.5	206.0
2.00	97.7	–	30.1	–	25.9	29.5	152.6	199.0
2.25	92.5	–	31.2	–	26.2	30.5	155.3	193.6
2.50	87.7	–	32.3	–	26.5	31.5	156.0	188.9
2.75	83.1	–	33.3	–	26.8	32.4	155.3	184.3
3.00	79.1	–	34.3	–	27.2	33.2	153.8	180.0
3.25	75.4	–	35.2	–	27.6	33.9	151.7	175.8
3.50	72.1	–	35.9	–	28.0	34.5	149.2	171.3
3.75	69.1	–	36.6	–	28.4	35.1	146.4	166.6
4.00	66.4	–	37.1	–	28.8	35.5	143.3	161.9
4.25	64.0	–	37.6	–	29.2	35.9	140.2	157.1
4.50	61.8	–	38.0	–	29.6	36.3	137.1	152.5
4.75	59.9	–	38.3	–	29.9	36.6	133.9	147.9
5.00	58.0	–	38.5	–	30.2	36.8	130.7	143.3
5.25	56.3	–	38.7	–	30.5	37.0	127.6	138.9
5.50	54.8	–	38.8	–	30.8	37.2	124.5	134.6
5.75	53.3	–	38.9	–	31.0	37.3	121.4	130.6
6.00	52.0	–	39.0	–	31.3	37.4	118.4	126.7
6.25	50.8	–	39.0	–	31.5	37.5	115.5	123.7
6.50	49.6	–	39.0	–	31.7	37.6	113.4	123.8
6.75	48.5	–	38.9	–	31.9	37.6	111.8	123.5
7.00	47.5	–	38.8	–	32.0	37.6	110.3	122.3
7.25	46.6	–	38.7	–	32.2	37.6	108.7	120.3
7.50	45.8	–	38.6	–	32.3	37.6	106.9	117.9
7.75	44.9	–	38.5	–	32.4	37.7	105.0	115.3
8.00	44.2	–	38.4	–	32.5	37.6	103.0	112.6
8.25	43.5	–	38.2	–	32.6	37.6	100.9	109.9
8.50	42.8	–	38.1	–	32.7	37.6	98.8	107.2
8.75	42.1	–	37.9	–	32.8	37.5	96.7	104.6
9.00	41.5	–	37.8	–	32.9	37.5	94.8	102.1
9.25	41.0	–	37.6	–	32.9	37.4	92.9	99.6
9.50	40.4	–	37.5	–	32.9	37.4	90.9	97.3
9.75	39.9	–	37.3	–	33.0	37.4	88.9	95.0

Table 4: (cont.)

Time (min.)	TC1	TC2[a]	TC3	TC4[a]	TC5	TC6	TC7	TC8
10.00	39.4	–	37.1	–	33.0	37.3	87.0	92.8
10.25	38.9	–	37.0	–	33.0	37.3	85.1	90.6
10.50	38.5	–	36.8	–	33.1	37.2	83.4	88.6
10.75	38.1	–	36.6	–	33.1	37.2	81.7	86.6
11.00	37.7	–	36.5	–	33.1	37.1	80.0	84.6
11.25	37.3	–	36.3	–	33.1	37.0	78.4	82.8
11.50	36.9	–	36.1	–	33.1	37.0	76.9	81.0
11.75	36.6	–	36.0	–	33.1	36.9	75.4	79.3
12.00	36.2	–	35.8	–	33.0	36.9	73.9	77.6
12.25	35.9	–	35.7	–	33.0	36.8	72.5	76.1
12.50	35.6	–	35.5	–	33.0	36.8	71.2	74.5
12.75	35.3	–	35.4	–	33.0	36.7	69.8	73.1
13.00	35.1	–	35.2	–	32.9	36.6	68.6	71.6
13.25	34.8	–	35.1	–	32.9	36.5	67.4	70.3
13.50	34.5	–	34.9	–	32.9	36.5	66.2	69.0
13.75	34.3	–	34.8	–	32.8	36.4	65.1	67.7
14.00	34.0	–	34.6	–	32.8	36.3	64.0	66.4
14.25	33.8	–	34.5	–	32.7	36.2	62.9	65.2
14.50	33.6	–	34.4	–	32.7	36.1	61.9	64.0
14.75	33.4	–	34.2	–	32.6	36.0	60.9	62.9
15.00	33.2	–	34.1	–	32.6	35.9	59.9	61.9
15.25	32.9	–	33.9	–	32.5	35.8	59.0	60.9
15.50	32.8	–	33.8	–	32.5	35.7	58.1	60.0
15.75	32.6	–	33.7	–	32.4	35.6	57.2	59.1
16.00	32.4	–	33.5	–	32.4	35.6	56.3	58.2
16.25	32.2	–	33.4	–	32.3	35.5	55.4	57.3
16.50	32.1	–	33.3	–	32.3	35.4	54.6	56.5
16.75	31.9	–	33.2	–	32.2	35.4	53.8	55.7
17.00	31.8	–	33.1	–	32.2	35.3	53.1	54.9
17.25	31.6	–	33.0	–	32.1	35.2	52.3	54.1
17.50	31.5	–	32.9	–	32.0	35.1	51.6	53.4
17.75	31.3	–	32.8	–	32.0	35.0	50.9	52.7
18.00	31.2	–	32.7	–	31.9	34.9	50.2	52.0
18.25	31.1	–	32.6	–	31.9	34.8	49.6	51.3
18.50	30.9	–	32.5	–	31.8	34.8	49.0	50.7
18.75	30.8	–	32.4	–	31.7	34.7	48.4	50.0
19.00	30.7	–	32.3	–	31.7	34.6	47.8	49.5
19.25	30.6	–	32.2	–	31.6	34.5	47.2	48.9
19.50	30.5	–	32.1	–	31.5	34.4	46.7	48.3
19.75	30.4	–	32.0	–	31.5	34.3	46.1	47.8
20.00	30.3	–	31.9	–	31.4	34.2	45.6	47.3

[a] TC2 and TC4 failed during the test.

Table 5: Temp. (°C) measured by thermocouples attached to substrate underside for Test 4

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
0.00	26.2	26.0	27.0	27.8	25.6	26.2	24.0	25.3
0.25	63.2	26.0	27.0	90.2	25.6	26.2	96.5	194.0
0.50	88.7	26.0	27.1	109.4	25.7	26.3	127.1	248.3
0.75	103.3	26.1	27.3	113.8	25.7	26.3	146.5	269.5
1.00	107.8	26.2	27.4	112.2	25.9	26.4	156.2	265.5
1.25	107.1	26.4	27.6	108.4	26.1	26.5	159.1	254.6
1.50	104.0	26.7	27.9	104.4	26.4	26.7	158.7	243.7
1.75	99.9	27.0	28.3	100.5	26.8	27.0	156.4	234.4
2.00	95.4	27.4	28.8	96.4	27.3	27.4	153.1	226.4
2.25	90.8	27.9	29.4	92.5	27.9	27.9	149.3	219.0
2.50	86.3	28.4	30.0	88.7	28.5	28.4	145.3	211.6
2.75	82.0	28.9	30.7	85.2	29.2	28.9	141.3	204.3
3.00	78.0	29.5	31.4	82.0	29.8	29.5	137.4	197.0
3.25	74.4	30.0	32.0	79.0	30.5	30.0	133.6	190.0
3.50	71.0	30.5	32.6	76.3	31.1	30.5	130.0	183.2
3.75	67.9	31.0	33.2	73.8	31.6	31.0	126.4	176.8
4.00	65.1	31.4	33.8	71.5	32.1	31.5	123.0	170.5
4.25	62.5	31.8	34.3	69.4	32.6	31.9	119.8	164.6
4.50	60.2	32.2	34.8	67.5	33.0	32.3	116.6	159.1
4.75	58.1	32.6	35.2	65.7	33.5	32.7	113.6	153.8
5.00	56.1	32.9	35.6	64.0	33.8	33.1	110.8	148.7
5.25	54.3	33.1	35.9	62.5	34.1	33.4	108.0	143.9
5.50	52.7	33.4	36.2	61.1	34.4	33.7	105.3	139.3
5.75	51.1	33.5	36.4	59.8	34.7	33.9	102.7	134.9
6.00	49.7	33.7	36.6	58.5	34.9	34.2	100.2	130.7
6.25	48.5	33.8	36.8	57.3	35.1	34.4	97.8	126.7
6.50	47.3	33.9	36.9	56.2	35.2	34.5	95.5	122.9
6.75	46.2	34.0	37.0	55.2	35.4	34.7	93.2	119.3
7.00	45.2	34.1	37.1	54.2	35.5	34.8	91.1	115.9
7.25	44.2	34.1	37.2	53.3	35.6	35.0	89.0	112.5
7.50	43.4	34.1	37.2	52.4	35.6	35.1	86.9	109.3
7.75	42.5	34.1	37.2	51.6	35.7	35.1	84.9	106.1
8.00	41.7	34.1	37.2	50.8	35.7	35.2	83.0	103.1
8.25	41.0	34.1	37.2	50.1	35.7	35.3	81.1	100.1
8.50	40.4	34.1	37.2	49.3	35.7	35.3	79.3	97.4
8.75	39.8	34.0	37.1	48.6	35.7	35.3	77.4	94.7
9.00	39.3	34.0	37.0	47.9	35.7	35.2	75.8	92.2
9.25	38.7	33.9	37.0	47.3	35.6	35.2	74.2	89.7
9.50	38.2	33.8	36.9	46.8	35.6	35.2	72.6	87.4
9.75	37.7	33.7	36.8	46.2	35.6	35.2	71.1	85.2

Table 5: (cont.)

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
10.00	37.2	33.6	36.7	45.7	35.5	35.2	69.7	83.0
10.25	36.8	33.6	36.6	45.1	35.5	35.2	68.3	81.0
10.50	36.3	33.5	36.5	44.7	35.4	35.2	66.9	79.0
10.75	35.9	33.4	36.4	44.2	35.3	35.1	65.6	77.1
11.00	35.6	33.3	36.3	43.7	35.3	35.1	64.4	75.3
11.25	35.2	33.3	36.1	43.3	35.2	35.1	63.2	73.6
11.50	34.9	33.2	36.0	42.9	35.1	35.0	62.0	72.0
11.75	34.5	33.1	35.9	42.5	35.0	35.0	60.9	70.4
12.00	34.2	33.0	35.8	42.1	34.9	34.9	59.8	68.9
12.25	33.9	32.9	35.7	41.7	34.8	34.9	58.8	67.6
12.50	33.7	32.8	35.5	41.4	34.8	34.8	57.8	66.2
12.75	33.4	32.7	35.4	41.0	34.7	34.7	56.8	64.9
13.00	33.1	32.7	35.3	40.7	34.6	34.7	55.9	63.6
13.25	32.9	32.6	35.1	40.4	34.5	34.6	55.0	62.4
13.50	32.7	32.5	35.0	40.1	34.4	34.5	54.1	61.2
13.75	32.4	32.4	34.9	39.8	34.3	34.5	53.3	60.1
14.00	32.2	32.3	34.8	39.5	34.2	34.4	52.4	59.0
14.25	32.0	32.2	34.6	39.3	34.2	34.3	51.6	58.0
14.50	31.9	32.1	34.5	39.0	34.1	34.3	50.9	56.7
14.75	31.7	32.0	34.4	38.7	34.0	34.2	50.1	55.3
15.00	31.5	31.9	34.3	38.5	33.9	34.1	49.4	54.2
15.25	31.3	31.8	34.1	38.3	33.8	34.1	48.6	53.1
15.50	31.2	31.6	34.0	38.0	33.7	34.0	48.0	52.2
15.75	31.0	31.5	33.9	37.8	33.6	33.9	47.3	51.4
16.00	30.9	31.4	33.8	37.6	33.5	33.8	46.7	50.5
16.25	30.8	31.3	33.7	37.4	33.4	33.7	46.0	49.7
16.50	30.6	31.2	33.5	37.2	33.3	33.7	45.5	49.0
16.75	30.5	31.2	33.4	37.0	33.2	33.6	44.9	48.3
17.00	30.4	31.1	33.3	36.8	33.1	33.5	44.3	47.6
17.25	30.3	31.0	33.2	36.6	33.0	33.4	43.8	47.0
17.50	30.2	31.0	33.1	36.4	32.9	33.3	43.3	46.4
17.75	30.1	30.9	33.0	36.3	32.9	33.2	42.8	45.8
18.00	30.0	30.8	32.9	36.1	32.8	33.2	42.3	45.2
18.25	29.9	30.7	32.8	36.0	32.7	33.1	41.8	44.6
18.50	29.8	30.7	32.7	35.8	32.6	33.0	41.4	44.0
18.75	29.7	30.6	32.6	35.6	32.5	32.9	40.9	43.5
19.00	29.6	30.5	32.5	35.5	32.4	32.9	40.5	43.0
19.25	29.5	30.4	32.4	35.3	32.3	32.8	40.1	42.5
19.50	29.4	30.4	32.4	35.2	32.3	32.7	39.7	42.0
19.75	29.3	30.3	32.3	35.0	32.2	32.6	39.3	41.6
20.00	29.3	30.3	32.2	34.9	32.1	32.5	38.9	41.1

Table 6: Temp. (°C) measured by thermocouples attached to substrate underside for Test 6

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
0.00	27.7	27.6	28.6	29.6	27.4	28.0	25.8	27.3
0.25	51.2	27.7	28.6	54.8	27.4	28.0	69.4	169.1
0.50	70.1	27.7	28.7	71.4	27.4	28.1	71.5	233.4
0.75	79.6	27.8	28.8	79.6	27.4	28.2	73.0	271.5
1.00	84.5	27.8	29.0	83.6	27.5	28.3	77.5	296.8
1.25	86.9	27.9	29.3	85.4	27.6	28.5	84.2	300.0
1.50	87.6	28.0	29.7	85.5	27.7	28.7	91.0	292.8
1.75	87.2	28.2	30.3	84.9	27.9	29.1	96.7	282.0
2.00	85.9	28.3	31.1	83.7	28.1	29.6	101.1	268.9
2.25	84.3	28.6	31.9	82.3	28.4	30.1	104.1	255.4
2.50	82.3	28.9	32.7	80.8	28.8	30.6	106.0	242.6
2.75	80.1	29.2	33.6	79.2	29.1	31.1	107.0	230.6
3.00	77.8	29.6	34.5	77.5	29.5	31.6	107.2	219.7
3.25	75.6	30.0	35.3	75.8	29.8	32.1	107.0	209.5
3.50	73.4	30.4	36.1	74.1	30.2	32.6	106.3	200.1
3.75	71.3	30.8	36.8	72.3	30.5	33.0	105.4	191.4
4.00	69.2	31.2	37.5	70.7	30.9	33.5	104.1	183.3
4.25	67.2	31.6	38.0	69.1	31.2	33.8	102.8	175.7
4.50	65.4	31.9	38.6	67.6	31.5	34.2	101.2	168.8
4.75	63.6	32.3	39.0	66.1	31.7	34.5	99.5	162.3
5.00	61.9	32.6	39.4	64.7	32.0	34.7	97.8	156.2
5.25	60.3	32.9	39.8	63.3	32.2	35.0	96.0	150.5
5.50	58.7	33.2	40.1	62.0	32.4	35.2	94.3	145.1
5.75	57.3	33.4	40.3	60.8	32.6	35.3	92.4	140.0
6.00	55.9	33.7	40.5	59.6	32.8	35.5	90.7	135.2
6.25	54.6	33.9	40.7	58.5	33.0	35.6	88.9	130.6
6.50	53.3	34.1	40.8	57.4	33.1	35.7	87.2	126.3
6.75	52.2	34.2	40.9	56.4	33.2	35.8	85.5	122.2
7.00	51.1	34.4	40.9	55.4	33.4	35.9	83.8	118.3
7.25	50.1	34.5	40.9	54.5	33.5	36.0	82.1	114.7
7.50	49.1	34.6	40.9	53.7	33.6	36.1	80.5	111.2
7.75	48.1	34.7	40.9	52.9	33.7	36.1	78.9	107.9
8.00	47.3	34.8	40.9	52.1	33.7	36.2	77.4	104.8
8.25	46.5	34.8	40.8	51.3	33.8	36.2	75.9	101.8
8.50	45.7	34.9	40.7	50.6	33.9	36.2	74.5	99.0
8.75	44.9	34.9	40.6	50.0	33.9	36.2	73.1	96.3
9.00	44.2	34.9	40.5	49.3	34.0	36.2	71.7	93.7
9.25	43.6	34.9	40.4	48.7	34.0	36.2	70.4	91.3
9.50	42.9	34.9	40.3	48.1	34.1	36.2	69.1	88.9
9.75	42.3	34.9	40.1	47.6	34.1	36.2	67.8	86.7

Table 6: (cont.)

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
10.00	41.7	34.9	40.0	47.0	34.1	36.2	66.6	84.6
10.25	41.2	34.9	39.9	46.5	34.1	36.2	65.4	82.5
10.50	40.7	34.9	39.8	46.0	34.1	36.2	64.3	80.6
10.75	40.2	34.8	39.6	45.5	34.1	36.1	63.2	78.7
11.00	39.7	34.8	39.5	45.1	34.1	36.1	62.1	76.9
11.25	39.3	34.7	39.3	44.6	34.1	36.0	61.0	75.2
11.50	38.9	34.6	39.2	44.2	34.1	36.0	60.1	73.6
11.75	38.4	34.6	39.0	43.8	34.0	36.0	59.1	72.1
12.00	38.1	34.5	38.9	43.4	34.0	35.9	58.2	70.6
12.25	37.7	34.4	38.7	43.0	33.9	35.9	57.3	69.2
12.50	37.3	34.3	38.6	42.7	33.9	35.8	56.4	67.8
12.75	37.0	34.3	38.4	42.3	33.9	35.8	55.5	66.5
13.00	36.7	34.2	38.3	42.0	33.8	35.7	54.7	65.2
13.25	36.4	34.1	38.1	41.7	33.8	35.7	53.9	64.0
13.50	36.1	34.0	38.0	41.3	33.7	35.6	53.1	62.8
13.75	35.8	33.9	37.9	41.1	33.7	35.5	52.3	61.7
14.00	35.5	33.8	37.7	40.8	33.6	35.5	51.6	60.6
14.25	35.3	33.7	37.6	40.5	33.6	35.4	50.9	59.6
14.50	35.0	33.6	37.4	40.2	33.5	35.3	50.2	58.5
14.75	34.8	33.6	37.3	40.0	33.5	35.3	49.5	57.6
15.00	34.6	33.5	37.2	39.7	33.4	35.2	48.9	56.6
15.25	34.4	33.4	37.0	39.5	33.4	35.1	48.2	55.7
15.50	34.2	33.3	36.9	39.2	33.3	35.1	47.6	54.8
15.75	34.0	33.2	36.8	39.0	33.3	35.0	47.0	54.0
16.00	33.8	33.1	36.6	38.8	33.2	34.9	46.5	53.1
16.25	33.6	33.1	36.5	38.6	33.2	34.8	45.9	52.5
16.50	33.4	32.9	36.4	38.4	33.1	34.7	45.4	51.6
16.75	33.3	32.8	36.3	38.2	33.1	34.7	44.9	50.9
17.00	33.1	32.7	36.1	38.0	33.0	34.6	44.4	50.2
17.25	33.0	32.7	36.0	37.9	32.9	34.5	43.9	49.5
17.50	32.8	32.6	35.9	37.7	32.9	34.5	43.4	48.9
17.75	32.7	32.5	35.8	37.5	32.8	34.4	42.9	48.2
18.00	32.6	32.5	35.6	37.3	32.8	34.3	42.5	47.6
18.25	32.4	32.4	35.5	37.2	32.7	34.2	42.0	47.1
18.50	32.3	32.3	35.4	37.0	32.7	34.1	41.6	46.5
18.75	32.2	32.2	35.3	36.9	32.6	34.1	41.2	46.0
19.00	32.1	32.2	35.2	36.7	32.5	34.0	40.8	45.4
19.25	32.0	32.1	35.1	36.6	32.5	33.9	40.4	44.9
19.50	31.9	32.0	35.0	36.4	32.4	33.8	40.0	44.4
19.75	31.8	32.0	34.9	36.3	32.4	33.8	39.7	43.9
20.00	31.7	31.9	34.8	36.2	32.3	33.7	39.3	43.5

Table 7: Temp. (°C) measured by thermocouples attached to substrate underside for Test 8

Time (min.)	TC1	TC2	TC3	TC4[a]	TC5	TC6	TC7	TC8
0.00	26.6	26.2	27.3	–	25.7	26.5	24.1	25.3
0.25	126.1	26.2	27.4	–	25.7	26.5	24.3	36.1
0.50	150.4	26.3	27.4	–	25.7	26.6	43.2	114.9
0.75	155.0	26.4	27.5	–	25.7	26.6	72.1	139.5
1.00	155.7	26.4	27.7	–	25.8	26.7	93.2	148.4
1.25	154.3	26.5	28.0	–	25.8	26.9	105.8	150.4
1.50	151.7	26.8	28.5	–	25.9	27.3	112.2	149.8
1.75	147.3	27.1	29.2	–	26.1	27.8	114.8	148.0
2.00	141.2	27.5	30.1	–	26.3	28.4	115.6	146.0
2.25	134.5	28.1	31.0	–	26.6	29.1	115.3	144.0
2.50	127.7	28.7	31.9	–	27.0	29.8	114.2	142.0
2.75	121.1	29.3	32.8	–	27.4	30.6	112.9	140.0
3.00	114.9	30.0	33.6	–	27.8	31.3	111.5	138.2
3.25	109.2	30.7	34.4	–	28.2	31.9	110.1	136.2
3.50	103.9	31.2	35.1	–	28.7	32.5	108.6	134.2
3.75	99.0	31.8	35.6	–	29.1	33.0	107.0	131.8
4.00	94.5	32.3	36.1	–	29.5	33.5	105.4	129.2
4.25	90.4	32.8	36.5	–	29.9	33.9	103.8	126.4
4.50	86.7	33.2	36.9	–	30.3	34.3	102.1	123.4
4.75	83.2	33.6	37.2	–	30.6	34.6	100.3	121.1
5.00	80.0	34.0	37.4	–	30.9	34.9	98.8	121.2
5.25	77.1	34.3	37.5	–	31.2	35.2	97.6	121.0
5.50	74.4	34.5	37.6	–	31.4	35.4	96.4	119.8
5.75	71.9	34.7	37.7	–	31.6	35.5	95.2	117.8
6.00	69.6	34.9	37.8	–	31.9	35.7	93.9	115.3
6.25	67.5	35.1	37.8	–	32.0	35.8	92.5	112.6
6.50	65.5	35.2	37.8	–	32.2	35.9	91.1	109.7
6.75	63.6	35.3	37.8	–	32.3	36.0	89.5	106.8
7.00	61.9	35.4	37.7	–	32.4	36.0	87.9	103.9
7.25	60.3	35.5	37.6	–	32.5	36.1	86.2	101.1
7.50	58.8	35.5	37.6	–	32.6	36.1	84.5	98.4
7.75	57.4	35.5	37.5	–	32.7	36.1	82.9	95.7
8.00	56.1	35.5	37.4	–	32.8	36.1	81.3	93.1
8.25	54.8	35.5	37.3	–	32.8	36.1	79.6	90.7
8.50	53.6	35.5	37.2	–	32.8	36.1	78.0	88.3
8.75	52.5	35.4	37.1	–	32.8	36.1	76.4	86.1
9.00	51.5	35.4	37.0	–	32.8	36.1	74.9	84.0
9.25	50.5	35.3	36.8	–	32.8	36.1	73.4	81.9
9.50	49.6	35.3	36.7	–	32.8	36.0	72.0	79.9
9.75	48.7	35.2	36.5	–	32.8	36.0	70.5	78.0
10.00	47.8	35.1	36.4	–	32.8	36.0	69.1	76.2

Table 7: (cont.)

Time (min.)	TC1	TC2	TC3	TC4[a]	TC5	TC6	TC7	TC8
10.25	47.1	35.0	36.3	–	32.8	35.9	67.8	74.5
10.50	46.3	34.9	36.1	–	32.8	35.9	66.5	72.8
10.75	45.6	34.8	36.0	–	32.8	35.8	65.2	71.2
11.00	44.9	34.7	35.9	–	32.8	35.8	64.0	69.7
11.25	44.3	34.6	35.7	–	32.7	35.7	62.8	68.2
11.50	43.6	34.5	35.6	–	32.7	35.7	61.7	66.8
11.75	43.0	34.4	35.5	–	32.6	35.6	60.6	65.4
12.00	42.5	34.3	35.3	–	32.6	35.6	59.5	64.2
12.25	42.0	34.2	35.2	–	32.6	35.5	58.5	62.9
12.50	41.4	34.0	35.1	–	32.5	35.4	57.5	61.7
12.75	41.0	33.9	34.9	–	32.5	35.4	56.6	60.6
13.00	40.5	33.8	34.8	–	32.4	35.3	55.7	59.6
13.25	40.1	33.7	34.7	–	32.4	35.3	54.8	58.5
13.50	39.6	33.6	34.5	–	32.3	35.2	53.9	57.5
13.75	39.2	33.5	34.4	–	32.2	35.1	53.1	56.6
14.00	38.8	33.3	34.3	–	32.2	35.1	52.2	55.7
14.25	38.5	33.2	34.2	–	32.1	35.0	51.4	54.8
14.50	38.1	33.1	34.0	–	32.1	34.9	50.7	53.9
14.75	37.8	33.0	33.9	–	32.0	34.9	50.0	53.1
15.00	37.4	32.9	33.8	–	32.0	34.8	49.2	52.3
15.25	37.1	32.8	33.7	–	31.9	34.7	48.6	51.5
15.50	36.8	32.6	33.6	–	31.9	34.7	47.9	50.8
15.75	36.5	32.5	33.4	–	31.8	34.6	47.3	50.1
16.00	36.2	32.4	33.4	–	31.7	34.5	46.7	49.4
16.25	36.0	32.4	33.3	–	31.7	34.5	46.1	48.7
16.50	35.7	32.3	33.2	–	31.6	34.4	45.5	48.1
16.75	35.5	32.2	33.1	–	31.5	34.3	44.9	47.5
17.00	35.2	32.1	33.0	–	31.5	34.2	44.4	46.9
17.25	35.0	32.0	32.9	–	31.4	34.2	43.9	46.3
17.50	34.7	31.9	32.8	–	31.4	34.1	43.3	45.7
17.75	34.5	31.8	32.6	–	31.3	34.0	42.8	45.2
18.00	34.3	31.7	32.5	–	31.3	34.0	42.3	44.6
18.25	34.1	31.6	32.4	–	31.2	33.9	41.9	44.1
18.50	33.9	31.5	32.4	–	31.1	33.8	41.4	43.6
18.75	33.7	31.4	32.3	–	31.1	33.7	41.0	43.1
19.00	33.5	31.3	32.2	–	31.0	33.7	40.6	42.6
19.25	33.3	31.2	32.1	–	31.0	33.6	40.2	42.2
19.50	33.1	31.1	32.0	–	30.9	33.5	39.8	41.7
19.75	32.9	31.1	31.9	–	30.9	33.4	39.4	41.3
20.00	32.8	31.0	31.8	–	30.8	33.4	39.0	40.9

[a] TC4 failed during the test.

Table 8: Temp. (°C) measured by thermocouples attached to substrate underside for Test 9

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
0.00	28.4	28.1	29.1	30.1	27.6	28.4	26.2	27.6
0.25	71.6	28.1	29.2	36.1	27.7	28.5	30.6	135.2
0.50	99.6	28.2	29.3	50.4	27.7	28.5	47.3	166.3
0.75	120.8	28.2	29.6	60.0	27.7	28.7	60.4	179.3
1.00	133.1	28.3	29.9	65.0	27.8	29.2	70.9	186.4
1.25	139.3	28.3	30.6	67.1	27.9	29.8	80.4	189.6
1.50	141.4	28.4	31.5	67.8	28.0	30.7	88.6	191.3
1.75	140.7	28.5	32.6	67.6	28.1	31.7	95.4	191.6
2.00	138.0	28.6	33.7	67.0	28.2	32.7	100.8	189.9
2.25	133.9	28.8	34.9	66.1	28.3	33.6	104.8	186.8
2.50	129.0	29.0	36.1	65.0	28.5	34.5	107.5	183.0
2.75	123.8	29.3	37.3	63.9	28.7	35.3	109.2	178.8
3.00	118.5	29.6	38.4	62.8	29.0	36.0	110.0	174.4
3.25	113.3	29.9	39.4	61.7	29.2	36.6	110.2	169.8
3.50	108.3	30.2	40.3	60.6	29.5	37.1	109.9	165.1
3.75	103.5	30.5	41.1	59.5	29.8	37.5	109.2	160.5
4.00	99.0	30.8	41.8	58.5	30.0	37.9	108.2	155.9
4.25	94.9	31.1	42.4	57.5	30.3	38.2	106.9	151.4
4.50	90.9	31.4	42.8	56.5	30.5	38.4	105.4	147.0
4.75	87.3	31.7	43.2	55.6	30.8	38.6	103.8	142.8
5.00	83.9	32.0	43.5	54.7	31.0	38.8	102.2	138.6
5.25	80.7	32.2	43.7	53.9	31.2	39.0	100.4	134.5
5.50	77.7	32.4	43.8	53.1	31.5	39.1	98.7	130.7
5.75	75.0	32.6	43.9	52.3	31.7	39.2	96.9	126.9
6.00	72.4	32.8	44.0	51.6	31.9	39.3	95.1	123.3
6.25	70.0	33.0	44.0	51.0	32.0	39.3	93.3	119.9
6.50	67.8	33.1	43.9	50.3	32.2	39.3	91.5	116.6
6.75	65.7	33.3	43.9	49.7	32.4	39.4	89.7	113.4
7.00	63.7	33.4	43.8	49.1	32.5	39.4	88.0	110.3
7.25	61.9	33.5	43.6	48.5	32.7	39.4	86.3	107.4
7.50	60.2	33.6	43.5	47.9	32.8	39.4	84.6	104.6
7.75	58.6	33.6	43.3	47.4	33.0	39.4	83.0	101.9
8.00	57.1	33.7	43.1	46.9	33.1	39.3	81.4	99.3
8.25	55.7	33.7	43.0	46.5	33.2	39.3	79.8	96.8
8.50	54.4	33.7	42.7	46.0	33.3	39.3	78.3	94.4
8.75	53.1	33.7	42.5	45.6	33.4	39.2	76.8	92.1
9.00	52.0	33.7	42.3	45.1	33.5	39.2	75.4	89.9
9.25	50.9	33.7	42.2	44.7	33.6	39.1	73.9	87.8
9.50	49.9	33.7	41.9	44.3	33.6	39.1	72.6	85.7
9.75	48.9	33.7	41.7	43.9	33.7	39.0	71.2	83.7

Table 8: (cont.)

Time (min.)	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8
10.00	48.0	33.6	41.5	43.6	33.7	38.9	69.9	81.9
10.25	47.2	33.6	41.3	43.2	33.8	38.9	68.7	80.0
10.50	46.4	33.6	41.1	42.9	33.8	38.8	67.4	78.3
10.75	45.6	33.5	40.9	42.6	33.9	38.7	66.2	76.6
11.00	44.9	33.5	40.7	42.3	33.9	38.7	65.1	75.0
11.25	44.2	33.4	40.5	42.0	33.9	38.6	64.0	73.5
11.50	43.6	33.4	40.3	41.7	34.0	38.5	62.9	72.0
11.75	43.0	33.3	40.1	41.4	34.0	38.4	61.9	70.5
12.00	42.4	33.2	39.9	41.2	34.0	38.3	60.8	69.1
12.25	41.9	33.2	39.7	40.9	34.0	38.2	59.9	67.8
12.50	41.4	33.1	39.5	40.6	34.0	38.1	58.9	66.5
12.75	40.9	33.1	39.3	40.4	34.0	38.1	58.0	65.3
13.00	40.4	33.0	39.1	40.2	34.0	38.0	57.1	64.2
13.25	40.0	32.9	38.9	39.9	34.0	37.8	56.2	63.0
13.50	39.6	32.9	38.7	39.7	34.0	37.7	55.4	61.9
13.75	39.2	32.8	38.5	39.5	34.0	37.6	54.6	60.8
14.00	38.8	32.8	38.4	39.3	34.0	37.5	53.8	59.8
14.25	38.4	32.7	38.2	39.1	33.9	37.4	53.0	58.8
14.50	38.1	32.6	38.0	38.9	33.9	37.3	52.3	57.9
14.75	37.7	32.6	37.8	38.7	33.9	37.2	51.6	57.0
15.00	37.4	32.5	37.7	38.5	33.9	37.1	50.9	56.1
15.25	37.1	32.4	37.5	38.4	33.8	37.1	50.2	55.2
15.50	36.8	32.4	37.3	38.2	33.8	36.9	49.6	54.4
15.75	36.6	32.3	37.2	38.0	33.8	36.9	48.9	53.6
16.00	36.3	32.2	37.0	37.9	33.7	36.7	48.3	52.9
16.25	36.1	32.2	36.8	37.7	33.7	36.6	47.7	52.1
16.50	35.8	32.1	36.7	37.6	33.7	36.5	47.2	51.4
16.75	35.6	32.0	36.5	37.4	33.6	36.4	46.6	50.7
17.00	35.4	32.0	36.4	37.3	33.6	36.3	46.1	50.1
17.25	35.2	31.9	36.3	37.1	33.5	36.2	45.5	49.4
17.50	35.0	31.8	36.1	37.0	33.5	36.1	45.0	48.8
17.75	34.8	31.7	36.0	36.9	33.4	36.0	44.5	48.2
18.00	34.6	31.7	35.8	36.7	33.4	35.9	44.0	47.6
18.25	34.4	31.6	35.7	36.6	33.3	35.8	43.6	47.1
18.50	34.2	31.5	35.6	36.5	33.3	35.7	43.1	46.5
18.75	34.1	31.5	35.5	36.4	33.3	35.6	42.7	46.0
19.00	33.9	31.4	35.3	36.3	33.2	35.5	42.3	45.5
19.25	33.7	31.4	35.2	36.2	33.2	35.4	41.9	45.0
19.50	33.6	31.3	35.1	36.1	33.1	35.3	41.5	44.6
19.75	33.4	31.2	35.0	36.0	33.1	35.2	41.1	44.1
20.00	33.3	31.2	34.9	35.9	33.0	35.1	40.8	43.7

2.3 Temperature measurements of salt and substrate surface by IR camera

The temperatures of the salt and substrate surface during and after molten salt spreading were recorded with an IR camera. Image processing techniques in MATLAB® were used to distinguish the salt from the substrate in the IR video frames; a description of the method is provided in Section 3.1.2.3 of Thomas and Jackson, 2021. The IR video records the temperature of each pixel in the field of view of the camera (resolution of 348 × 464 pixels) at a rate of 30 frames per second. The IR video data files have been exported as .csv files and are available from the authors upon reasonable request. These data files have been processed to correct for the temperature measurement of stainless steel (as described in Appendix B of Thomas and Jackson, 2021) and consist of two sets of data. The first dataset contains separate files of the salt surface temperature and the substrate surface temperature that were collected at 30 frames per second for the first 17 seconds of the test. The salt and substrate are distinguished in their respective files by setting the pixel values of the other material to “NaN”. The second dataset contains separate files of the salt surface temperature and the substrate surface temperature that were collected at 5 frames per second to provide cooling information. The total number of frames available varies by test. A file that shows the time stamp for each frame is also provided for each dataset.

The pixel coordinates of the corners of the stainless steel substrate are provided in Table 9. A schematic that identifies the pixel coordinates relative to the direction of the salt flow is provided in Figure 2. It is important to note that the temperature measurement of the stainless steel surface using the IR camera is highly sensitive to the temperature of surrounding objects due to the low emissivity of stainless steel. Although accounted for in image processing, the reflection of radiation from adjacent objects may be apparent on the stainless steel surface in the data files. The temperature value in the data file was set to “NaN” if the corrected temperature of the stainless steel surface was below 22 °C. The salt temperature measured by the IR camera is not sensitive to the temperature of adjacent objects due to the high emissivity of the salt.

Table 9: The coordinates of the corners of the stainless steel substrate in pixels

Test	x_1	y_1	x_2	y_2	x_3	y_3	x_4	y_4
1	128	22	316	15	120	415	299	430
2	74	29	262	24	77	431	256	436
3	41	17	236	14	48	439	233	436
4[a]	118	13	300	13	127	413	299	413
5[b]	22	1	268	1	28	464	250	464
6	103	26	281	28	110	431	281	436
7[c,d]	70	9	261	3	84	420	255	422
8[c,d]	49	37	225	37	49	453	225	453
9[d]	159	42	348	44	155	443	333	448

[a] A platinum foil is blocking the bottom 1 in. of the substrate from the camera field of view.
[b] The bottom 1.5 in. of the substrate is out of the camera field of view and the edge of the stainless steel substrate is provided instead.
[c] The provided coordinates of the corners of the stainless steel substrate are estimates because the boundary could not be distinguished in the IR video.
[d] The stainless steel surface temperature was not measured because a higher temperature calibration setting was required to measure the salt temperature with the IR camera.

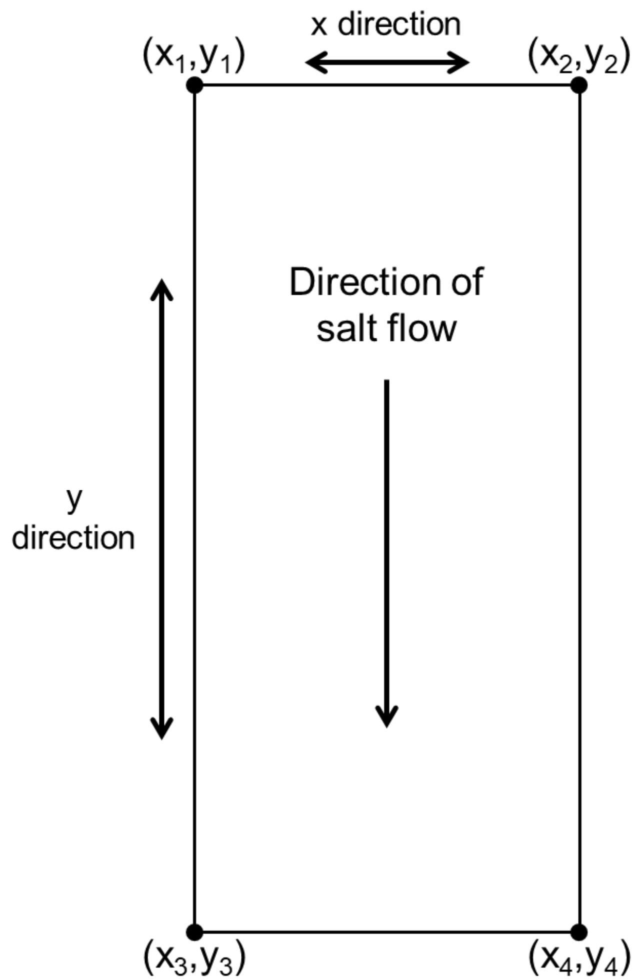

Figure 2: Schematic of the coordinates of the stainless steel substrate boundary relative to the direction of the salt flow.

A summary of the pixel coordinates in the IR video frames that provide locations of the thermocouples attached to the substrate underside for each test are available upon reasonable request. The temperature information obtained from the thermocouples attached to the substrate underside surface and from the IR camera of the substrate upper surface or the salt surface at the same location could be used for heat transfer analysis.

2.4 Leading edge and covered area as a function of time

The leading edge and covered area of the salt on the substrate for each still frame recorded by the IR camera were determined using the methods described in Section 3.1.2.3 in Thomas and Jackson, 2021 and are provided for each test in Table 10 and Table 11, respectively.

Table 10: Leading edge position (mm) of molten salt spreading on stainless steel substrate

	Test Number								
Time (ms)	1	2	3	4[a]	5[b]	6	7	8	9
0	0	0	0	–	0	0	0	0	0
33	1.4	15.4	11.9	–	4.4	1.4	8.0	5.4	1.4
66	5.8	19.7	14.5	–	12.2	5.7	14.7	12.2	2.9
100	10.1	29.5	18.5	–	15.5	8.5	16.0	15.0	5.7
133	14.4	37.9	21.1	–	21.0	12.7	21.4	17.7	5.7
166	18.7	46.3	22.4	–	24.4	18.4	24.1	17.7	10.0
200	21.6	51.9	26.4	–	26.6	22.6	28.1	20.4	15.7
233	25.9	60.4	29.0	–	32.1	28.3	32.1	23.1	20.0
266	30.2	68.8	33.0	–	35.4	34.0	37.4	25.8	27.2
300	33.1	77.2	36.9	–	39.9	39.6	42.8	28.6	32.9
333	37.4	87.0	39.5	–	44.3	45.3	49.5	32.6	40.0
366	43.2	98.3	42.2	–	50.9	50.9	56.2	36.7	48.6
400	47.5	109.5	46.1	–	56.5	56.6	62.8	40.8	57.2
433	51.8	120.7	50.1	–	64.2	107.5	69.5	46.2	64.4
466	57.6	134.8	54.0	–	72.0	67.9	77.5	50.3	72.9
500	63.4	134.8	58.0	–	79.7	75.0	85.6	57.1	81.5
533	79.2	147.4	61.9	–	88.6	82.1	92.3	62.6	90.1
566	73.4	161.5	67.2	–	97.4	89.1	101.6	66.6	98.7
600	79.2	175.5	71.2	–	106.3	96.2	111.0	72.1	107.3
633	85.0	190.9	76.4	–	117.3	103.3	120.3	77.5	117.3
666	92.2	206.4	81.7	–	128.4	103.3	129.7	84.3	127.3
700	97.9	221.8	87.0	–	140.6	111.8	140.4	89.8	137.3
733	103.7	235.9	92.3	–	151.7	120.3	151.1	96.6	147.3
766	110.9	251.3	98.9	–	163.8	130.2	161.8	103.4	157.3
800	118.1	268.2	105.4	–	176.0	138.7	171.1	108.8	168.7
833	125.3	285.0	112.0	–	189.3	148.6	181.8	115.6	180.2
866	132.5	301.9	119.9	–	202.6	157.1	192.5	123.8	191.6
900	139.7	320.1	126.5	–	217.0	167.0	203.2	130.6	203.1
933	146.9	337.0	133.1	–	232.5	176.9	215.3	137.4	214.5
966	154.1	355.2	141.0	–	248.0	188.2	226.0	145.5	225.9
999	161.3	374.9	148.9	–	263.5	198.1	236.7	152.3	238.8
1033	168.5	393.1	155.5	–	280.1	209.4	248.7	160.5	250.3
1066	177.1	411.4	163.4	–	296.7	220.7	259.4	168.6	263.1
1099	185.8	431.0	171.3	–	313.3	232.1	271.4	175.4	276.0
1133	193.0	450.7	179.3	–	329.9	243.4	282.1	183.6	287.4
1166	201.6	468.9	185.8	–	347.6	254.7	294.1	190.4	300.3
1199	210.2	490.0	193.8	–	365.3	266.0	304.8	197.2	313.2
1233	218.9	509.7	203.0	–	384.1	278.8	315.5	205.4	326.0
1266	227.5	530.7	210.9	–	401.8	291.5	326.2	212.2	338.9
1299	237.6	546.2	218.8	–	–	304.2	336.9	219.0	351.8
1333	246.2	–	226.7	–	438.4	315.6	347.6	225.8	364.7
1366	256.3	–	234.6	–	456.1	328.3	358.3	233.9	379.0
1399	266.4	–	234.6	–	473.8	339.6	367.7	243.4	393.3

Table 10: (cont.)

	Test Number								
Time (ms)	1	2	3	4[a]	5[b]	6	7	8	9
1433	276.5	–	243.8	–	491.5	352.3	377.0	250.2	407.6
1466	288.0	–	253.1	–	–	365.1	386.4	259.8	420.4
1499	298.1	–	261.0	–	502.6	377.8	394.4	267.9	436.2
1533	309.6	–	270.2	–	–	390.5	403.8	267.9	450.5
1566	319.7	–	278.1	–	–	403.3	410.5	276.1	464.8
1599	331.2	–	286.0	–	–	417.4	418.5	285.6	479.1
1633	341.3	–	295.2	–	–	430.2	423.8	293.8	493.4
1666	352.8	–	304.5	–	–	444.3	430.5	301.9	507.7
1699	364.3	–	312.4	–	–	458.5	435.9	310.1	522.0
1733	374.4	–	321.6	–	–	472.6	439.9	318.2	536.3
1766	385.9	–	330.8	–	–	486.8	445.2	326.4	550.6
1799	397.4	–	338.7	–	–	500.9	449.2	334.6	–
1833	409.0	–	348.0	–	–	513.6	457.3	342.7	–
1866	421.9	–	355.9	–	–	529.2	469.3	350.9	–
1899	433.4	–	363.8	–	–	540.5	481.3	359.0	–
1933	446.4	–	373.0	–	–	–	494.7	368.6	–
1966	457.9	–	382.2	–	–	–	506.7	376.7	–
1999	469.4	–	391.5	–	–	–	520.1	384.9	–
2033	482.4	–	400.7	–	–	–	530.8	394.4	–
2066	492.5	–	409.9	–	–	–	–	402.6	–
2099	504.0	–	419.1	–	–	–	–	412.1	–
2133	514.1	–	427.0	–	–	–	–	420.2	–
2166	524.2	–	434.9	–	–	–	–	428.4	–
2199	534.2	–	444.2	–	–	–	–	436.6	–
2233	544.3	–	452.1	–	–	–	–	444.7	–
2266	–	–	460.0	–	–	–	–	452.9	–
2299	–	–	467.9	–	–	–	–	461.0	–
2333	–	–	475.8	–	–	–	–	469.2	–
2366	–	–	483.7	–	–	–	–	477.4	–
2399	–	–	491.6	–	–	–	–	485.5	–
2433	–	–	499.5	–	–	–	–	492.3	–
2466	–	–	506.1	–	–	–	–	500.5	–
2499	–	–	512.7	–	–	–	–	507.3	–
2533	–	–	519.3	–	–	–	–	514.1	–
2566	–	–	527.2	–	–	–	–	520.9	–
2599	–	–	535.1	–	–	–	–	527.7	–
2633	–	–	545.7	–	–	–	–	533.1	–
2666	–	–	–	–	–	–	–	539.9	–
2699	–	–	–	–	–	–	–	545.4	–
2733	–	–	–	–	–	–	–	550.8	–
2766	–	–	–	–	–	–	–	557.6	–

[a] The leading edge data was not usable for this test.
[b] The final 1.5 in. of the substrate was out of the field of view of the IR camera.

Table 11: Covered area (mm^2) of molten salt spreading on stainless steel substrate

	Test Number								
Time (ms)	1	2	3	4[a]	5[b]	6	7	8	9
0	0	0	0	0	0	0	0	0	0
33	19.9	271.0	147.7	82.9	53.5	31.3	60.4	43.0	35.8
66	105.3	403.1	187.3	145.5	131.0	116.3	166.6	101.9	73.1
100	170.8	545.4	248.6	269.0	203.2	197.7	187.8	150.7	135.1
133	232.0	726.9	307.1	382.9	285.0	280.3	260.0	203.1	135.1
166	339.2	919.3	351.4	480.1	372.7	388.3	326.8	219.0	223.5
200	418.1	1108.6	457.7	628.9	434.7	462.2	377.8	262.4	375.7
233	503.2	1287.5	502.9	776.9	564.3	567.7	478.2	333.0	565.2
266	601.1	1464.6	566.3	935.8	664.9	679.8	555.9	396.3	742.5
300	676.5	1667.2	664.0	1120.6	761.5	779.5	622.3	489.2	883.3
333	764.9	1878.2	733.8	1296.3	880.7	897.3	675.5	591.1	1028.7
366	874.5	2065.3	805.1	1467.1	999.7	1013.3	789.9	679.9	1174.9
400	972.9	2275.5	913.0	1660.8	1114.1	1140.0	847.5	790.5	1350.4
433	1068.4	2522.9	1036.1	1829.8	1262.7	1277.4	904.2	910.3	1507.8
466	1179.4	2770.2	1143.3	2046.6	1416.5	1424.9	988.0	1007.6	1648.6
500	1300.2	2770.2	1256.4	2267.2	1585.7	1602.7	1055.6	1107.7	1791.9
533	1398.6	3012.3	1366.0	2432.9	1752.4	1739.9	1127.6	1183.4	1964.1
566	1520.5	3212.3	1498.3	2603.9	1939.9	1873.0	1215.0	1280.2	2107.4
600	1651.6	3468.6	1635.5	2829.5	2105.0	2085.6	1286.1	1396.6	2284.0
633	1770.7	3674.5	1757.6	3029.7	2293.9	2251.2	1357.5	1510.2	2434.6
666	1897.5	3905.3	1885.2	3233.8	2448.6	2251.2	1433.0	1596.2	2650.1
700	2022.0	4106.9	2055.4	3441.0	2602.7	2432.9	1511.1	1700.2	2837.0
733	2145.8	4339.5	2198.6	3655.7	2768.6	2627.2	1593.6	1836.1	3032.2
766	2263.6	4548.7	2338.2	3901.7	2910.1	2808.0	1648.8	1973.4	3186.7
800	2391.4	4824.6	2491.6	4103.3	3027.9	2961.0	1710.7	2121.8	3345.4
833	2541.6	5078.0	2662.3	4103.3	3199.9	3132.3	1763.5	2235.4	3463.6
866	2647.1	5244.2	2839.6	4292.6	3382.4	3322.4	1820.8	2344.4	3638.1
900	2769.5	5492.4	2985.1	4483.1	3571.8	3490.1	1904.2	2429.3	3752.6
933	2903.1	5696.5	3112.1	4706.8	3708.1	3658.3	2011.5	2560.4	3887.2
966	3038.2	5908.0	3252.3	4924.4	3819.1	3823.4	2058.1	2635.1	3980.5
999	3168.3	6124.3	3453.3	5124.1	3967.2	4010.2	2141.7	2723.7	4060.6
1033	3318.1	6352.3	3584.3	5308.8	4107.0	4178.4	2245.0	2794.0	4174.4
1066	3456.6	6555.4	3725.1	5485.8	4238.1	4239.7	2292.9	2861.4	4311.1
1099	3603.5	6740.4	3885.6	5681.7	4349.8	4408.9	2329.3	2954.8	4447.7
1133	3711.7	6957.0	4038.5	5857.1	4431.0	4548.7	2346.1	2959.4	4527.5
1166	3866.5	7141.8	4190.7	6049.6	4538.2	4712.2	2368.7	3040.4	4603.2
1199	4022.9	7375.9	4343.5	6248.8	4663.4	4855.9	2416.2	3122.3	4744.5
1233	4130.3	7564.5	4528.9	6436.6	4732.8	4980.2	2440.2	3201.6	4780.8
1266	4252.2	7777.8	4672.1	6629.4	4750.1	5106.8	2463.2	3280.0	4899.3
1299	4431.2	7952.4	4824.8	6820.3	–	5253.0	2512.2	3338.9	4926.0
1333	4528.0	–	4993.2	6976.1	4858.8	5366.7	2550.8	3386.5	4964.9
1366	4703.7	–	5113.3	7168.1	4926.6	5442.4	2596.1	3462.9	5042.2
1399	4883.5	–	5113.3	7299.6	4932.3	5616.3	2634.2	3564.8	5095.3

Table 11: (cont.)

Time (ms)	Test Number 1	2	3	4[a]	5[b]	6	7	8	9
1433	5020.3	–	5263.7	7483.3	5020.4	5772.1	2673.1	3624.8	5164.3
1466	5166.4	–	5421.9	7596.0	–	5881.6	2722.4	3701.9	5238.9
1499	5356.5	–	5546.7	7717.7	4862.5	6030.2	2748.0	3798.0	5315.4
1533	5467.2	–	5685.0	7806.0	–	6149.1	2767.2	3798.0	5384.1
1566	5626.3	–	5846.3	7918.7	–	6312.1	2820.6	3813.9	5465.5
1599	5778.4	–	5980.0	8033.4	–	6467.6	2866.4	3890.0	5487.8
1633	5920.4	–	6135.4	8147.3	–	6555.2	2912.6	3970.0	5478.5
1666	6041.1	–	6260.4	8251.5	–	6696.3	2914.3	4005.0	5520.7
1699	6189.6	–	6382.5	8333.6	–	6812.3	2924.6	4051.0	5532.4
1733	6302.5	–	6518.0	8437.0	–	6896.0	2899.9	4088.5	5624.2
1766	6462.7	–	6634.3	–	–	6972.0	2879.7	4150.1	5672.1
1799	6590.3	–	6764.4	–	–	7089.3	2879.5	4175.7	–
1833	6721.7	–	6879.4	–	–	7126.2	2938.8	4287.9	–
1866	6853.0	–	7039.0	–	–	7189.0	3001.4	4307.7	–
1899	6996.7	–	7180.7	–	–	7353.9	2974.5	4331.8	–
1933	7122.6	–	7273.1	–	–	–	2967.5	4396.0	–
1966	7253.4	–	7444.4	–	–	–	2961.4	4406.8	–
1999	7364.1	–	7551.3	–	–	–	2928.1	4471.7	–
2033	7485.4	–	7653.3	–	–	–	2978.0	4449.1	–
2066	7592.1	–	7776.0	–	–	–	–	4480.6	–
2099	7703.0	–	7883.8	–	–	–	–	4525.0	–
2133	7812.9	–	7975.7	–	–	–	–	4548.5	–
2166	7887.7	–	8075.2	–	–	–	–	4553.8	–
2199	7999.2	–	8216.6	–	–	–	–	4564.8	–
2233	8100.2	–	8302.8	–	–	–	–	4576.5	–
2266	–	–	8412.9	–	–	–	–	4640.9	–
2299	–	–	8514.3	–	–	–	–	4652.9	–
2333	–	–	8592.4	–	–	–	–	4684.2	–
2366	–	–	8686.9	–	–	–	–	4669.7	–
2399	–	–	8775.9	–	–	–	–	4683.5	–
2433	–	–	8847.4	–	–	–	–	4713.2	–
2466	–	–	8925.5	–	–	–	–	4722.8	–
2499	–	–	9026.2	–	–	–	–	4704.4	–
2533	–	–	9075.7	–	–	–	–	4751.3	–
2566	–	–	9171.5	–	–	–	–	4724.4	–
2599	–	–	9256.8	–	–	–	–	4731.1	–
2633	–	–	9329.6	–	–	–	–	4759.9	–
2666	–	–	–	–	–	–	–	4760.8	–
2699	–	–	–	–	–	–	–	4779.4	–
2733	–	–	–	–	–	–	–	4797.6	–
2766	–	–	–	–	–	–	–	4843.3	–

[a] A 1 in. wide platinum foil blocked the substrate bottom from the field of view of the IR camera.
[b] The final 1.5 in. of the substrate was out of the field of view of the IR camera.

2.5 Thermocouple measurements of atmosphere temperature above pool

A thermocouple placed above the molten salt pool that forms at the bottom of the substrate was used to record the temperature of the atmosphere as a function of time since the salt was first poured onto the substrate. The location of the thermocouple was different in each test, and the thermocouple location relative to the center of the molten salt pool is provided in Table 12. The measurements from the thermocouple above the molten salt pool are provided in Table 13.

Table 12: Description of thermocouple location above molten salt pool[a]

Test	Thermocouple location relative to molten salt pool
2	6" above
3	1" above, 4" off center of pool
5	6" above
7	0.9" above
8	2" above, 1" off center of pool

[a] Data from Tests 1, 4, 6, and 9 are unavailable.

Table 13: Temp. (°C) measured by thermocouple above molten salt pool for spreading tests[a]

Time (min.)	Test				
	2	3	5	7	8
0.00	25.5	25.2	28.3	25.4	25.5
0.25	25.6	25.4	28.4	37.3	25.9
0.50	25.7	26.2	28.6	54.1	29.6
0.75	25.8	26.8	28.8	69.7	33.3
1.00	25.9	27.4	28.9	81.0	36.5
1.25	25.9	28.0	29.0	93.0	39.6
1.50	26.0	28.6	29.0	100.5	42.7
1.75	26.0	29.4	29.1	106.4	45.8
2.00	26.1	30.1	29.1	109.6	49.3
2.25	26.1	30.9	29.2	111.2	51.8
2.50	26.1	31.6	29.2	111.0	55.0
2.75	26.1	32.4	29.2	110.4	56.4
3.00	26.1	33.4	29.2	110.1	57.6
3.25	26.2	34.4	29.2	109.0	59.1
3.50	26.2	35.3	29.1	107.4	59.4
3.75	26.2	36.4	29.1	105.8	59.7

[a] Data from Tests 1, 4, 6, and 9 are unavailable.

Table 13: (cont.)

Time (min.)	Test 2	3	5	7	8
4.00	26.2	37.3	29.1	103.6	58.9
4.25	26.2	38.1	29.1	101.5	58.3
4.50	26.2	39.0	29.1	99.2	57.0
4.75	26.1	39.7	29.1	97.3	56.4
5.00	26.1	40.4	29.0	95.0	55.6
5.25	26.1	40.7	29.0	93.1	54.9
5.50	26.1	40.9	29.0	91.6	53.5
5.75	26.1	41.2	29.0	89.9	52.3
6.00	26.1	41.6	28.9	87.9	50.6
6.25	26.1	41.8	28.9	85.9	49.1
6.50	26.1	42.1	28.9	83.7	47.5
6.75	26.0	42.4	28.9	81.8	46.4
7.00	26.0	42.7	28.8	80.0	45.1
7.25	26.0	42.8	28.8	78.3	44.2
7.50	26.0	43.1	28.8	76.6	43.0
7.75	26.0	43.0	28.8	75.0	41.8
8.00	26.0	42.9	28.7	72.9	40.7
8.25	26.0	43.0	28.7	71.5	40.3
8.50	26.0	43.0	28.7	70.2	40.4
8.75	26.0	43.2	28.7	68.8	39.4
9.00	25.9	43.0	28.7	67.4	39.2
9.25	25.9	42.7	28.7	66.0	38.4
9.50	25.9	42.9	28.6	64.7	37.6
9.75	25.9	43.0	28.6	63.4	36.9
10.00	25.9	43.0	28.6	62.1	36.3
10.25	25.9	43.1	28.6	60.8	35.7
10.50	25.9	43.2	28.6	59.7	35.1
10.75	25.9	43.0	28.6	58.5	34.8
11.00	25.8	42.9	28.6	57.3	34.5
11.25	25.8	42.8	28.5	56.3	33.9
11.50	25.8	42.8	28.5	55.2	33.7
11.75	25.8	42.9	28.5	54.3	33.3
12.00	25.8	42.8	28.5	53.3	32.8
12.25	25.8	42.5	28.5	52.3	32.6
12.50	25.8	42.4	28.5	51.5	32.2
12.75	25.8	42.3	28.5	50.7	31.7

[a] Data from Tests 1, 4, 6, and 9 are unavailable.

2.6 Thickness measurements of frozen salt by location

The thickness of the salt that pooled at the end of the substrate and the thickness of the crust that formed on the substrate upstream from the pooled salt were measured for some tests and the mean and standard deviation of three measurements are provided in Table 14.

Table 14: Thickness of frozen salt crust and pool after spreading (mm)[a]

Test	Crust	Pool
1	1[b]	3.0 ± 0.2
4	1.8 ± 0.3	5.1 ± 0.1
6	2.5 ± 1.3	4.4 ± 0.3
9	2.0 ± 0.6	4.3 ± 0.3

[a] The provided values are the mean ± one standard deviation of three measurements.
[b] Only one measurement was taken.

2.7 Glovebox conditions

The measured temperature, O_2 content, and H_2O content of the atmosphere of the argon atmosphere glovebox recorded before and after each spreading test are provided in Table 15.

Table 15: The O_2 content, H_2O content, and temperature of the glovebox atmosphere measured before and after each test

	O_2 content (ppm)		H_2O content (ppm)		Temp. (°C) of atmosphere		
Test	Before	After	Before	After	Before	After	Max.
1	3	3	< 1	< 1	27	27	27
2	< 1	< 1	< 1	< 1	26	26	26
3	< 1	< 1	< 1	< 1	28	26	28
4	5	5	< 1	< 1	26	26	27
5	< 1	< 1	< 1	< 1	28	29	29
6	2	2	< 1	< 1	28	27	28
7	< 1	< 1	< 1	< 1	27	27	28
8	< 1	< 1	< 1	< 1	30	28	30
9	2	2	< 1	< 1	28	28	29

2.8 Composition of frozen salt

The concentrations of the major cations and the trace metals in the source batch of FLiNaK used for these tests reported by Lichtenstein et al., 2020 are reproduced in Table 16 and Table 17, respectively. The major cation concentrations were determined by using ICP-OES and the trace metal concentrations were determined by using ICP-MS (Lichtenstein et al., 2020). Contamination from the ceramic mortar and pestle used to grind the FLiNaK into a powder is likely responsible for the high calcium concentration reported in Table 17. That contamination may affect the salt property values slightly but does not affect insights drawn from the studies described herein.

Table 16: Concentrations of major components in FLiNaK before the tests (mol %)

Sample	LiF	NaF	KF
1	47.0	11.6	41.4
2	46.3	11.6	42.1
3	46.1	11.3	42.6
Mean ± 1σ	46.5 ± 0.5	11.5 ± 0.2	42.0 ± 0.6

Table 17: Concentrations of trace metals in the salt before the tests (ppm)[a]

Sample	Ca	Cr	Mn	Fe	Ni	Rb	Cs
1	1490	< 11	< 4	< 200	115	31.9	2.3
2	944	< 8	< 2	< 140	137	25.8	1.8
3	510	< 7	< 3	< 120	118	26.3	1.4
Mean ± 1σ	980 ± 490	–	–	–	123 ± 12	28 ± 3	1.8 ± 0.4

[a] The number after < is the detection limit.

The salt that froze on the stainless steel sheet was analyzed for major cation (lithium, sodium, and potassium) and trace metal (calcium, manganese, iron, nickel, chromium, cesium, and rubidium) concentrations by using ICP-MS following the methods reported in Section 2.3 in Thomas and Jackson, 2021. Frozen salt samples were taken from different locations on the stainless steel substrate to compare compositions within the flow path. Table 18 and Table 19 provide the concentrations of major components and trace metals, respectively, that were measured in the salt that was recovered after spreading for each test.

Table 18: Composition of frozen salt samples collected from spreading tests

Test	CsF & CsI in salt?	Sample type	LiF (mol %)	NaF (mol %)	KF (mol %)	CsF (mol %)	CsI[a] (mol %)
1	No	Crust	47.7	11.1	41.2	–	–
		Pool	46.7	11.0	42.3	–	–
2	No	Crust	47.3	11.2	41.5	–	–
		Pool	47.5	11.4	41.2	–	–
3	No	Pool 1	47.5	11.3	41.2	–	–
		Pool 2	47.4	11.4	41.2	–	–
4	Yes	Crust	46.3	11.0	41.8	0.82	0.04
		Pool	46.9	11.1	41.2	0.80	0.06
5	No	Crust	47.4	11.4	41.2	–	–
		Pool	–	–	–	–	–
6	No	Crust	47.2	11.1	41.7	–	–
		Pool	47.6	11.1	41.3	–	–
7	No	Crust	–	–	–	–	–
		Pool	47.3	11.7	41.0	–	–
8	No	Crust	–	–	–	–	–
		Pool	47.6	11.5	41.0	–	–
9	No	Crust	47.4	11.3	41.3	–	–
		Pool	47.6	11.3	41.1	–	–
Crust mean (± 1σ)[b]			47.4 ± 0.2	11.3 ± 0.1	41.3 ± 0.2	–	–
Pool mean (± 1σ)[b]			47.4 ± 0.3	11.3 ± 0.3	41.3 ± 0.5	–	–

[a] Mol % of CsI was calculated assuming all detected iodine was present as CsI.
[b] The results from Test 4 were excluded from the mean.

Table 19: Trace metal composition of frozen salt samples collected from spreading tests[a,b]

Test	CsF & CsI in salt?	Sample type	Ca (ppm)	Cr (ppm)	Mn (ppm)	Fe (ppm)	Ni (ppm)	Rb (ppm)	Cs[c] (ppm)
1	No	Crust	1000	< 1.5	< 2.2	< 38.9	5.8	22.5	10.7
		Pool	616	< 1.3	< 2.6	< 34.9	23.2	22.4	2.2
2	No	Crust	359	< 2.6	1.5	13.7	26.3	24.2	1.4
		Pool	344	< 1.3	1.8	14.3	8.9	23.5	1.5
3	No	Crust	204	< 1.7	4.1	8.9	16.5	23.4	1.5
		Pool	1370	< 1.7	3.9	25.7	7.6	24.0	1.5
4	Yes	Crust	< 181	< 1.5	2.7	< 46.0	20.3	21.8	–
		Pool	< 210	< 1.5	2.8	< 45.9	43.3	21.8	–
5	No	Crust	932	< 1.3	6.2	12.9	2.6	23.9	1.5
		Pool	–	–	–	–	–	–	–
6	No	Crust	955	< 1.9	4.7	< 51.7	8.1	21.8	22.6
		Pool	392	< 1.1	3.4	< 29.8	17.8	21.5	2.1
7	No	Crust	–	–	–	–	–	–	–
		Pool	581	< 1.3	8.1	6.47	< 0.5	23.8	1.4
8	No	Crust	–	–	–	–	–	–	–
		Pool	338	< 1.5	6.0	23.1	3.8	22.7	1.3
9	No	Crust	912	< 1.8	5.0	< 42.1	10.6	21.2	5.4
		Pool	608	< 1.1	4.4	< 28.2	7.2	21.4	4.5
Crust mean (± 1σ)[c]			730 ± 350	–	4 ± 2	–	13 ± 9	23 ± 1	7 ± 8
Pool mean (± 1σ)[c]			610 ± 360	–	4 ± 2	–	16 ± 14	23 ± 1	2 ± 1

[a] The number after < is the detection limit.
[b] The Cs concentration of FLiNaK doped with CsF and CsI (Test 4) is reported in Table 18.
[c] The results from Test 4 were excluded from the mean.

2.9 Composition of condensation on platinum foil

Condensed vapor from the pool of molten salt containing cesium and iodine as surrogate fission products that formed at the end of the stainless steel sheet was collected on an acid-washed platinum foil (7.5 cm^2). The foil was placed above the location where the salt pools and was supported by the wall of the stainless steel sheet and a stainless steel rod on two sides (Figure 3). A control foil that was exposed to the glovebox atmosphere for approximately one hour was also tested. After the test, the platinum foil was rinsed with water and the water was analyzed for lithium, sodium, potassium, cesium, and iodine by using ICP-MS. The results from the water rinse are provided in Table 20.

A subsequent acid leach was performed on the platinum foil and the leachate was analyzed for lithium, sodium, potassium, and cesium by using ICP-MS (Table 20). Little additional lithium, sodium, potassium, or cesium was recovered by the acid leach, which indicates a water leach is sufficient for quantifying condensate that forms on a platinum foil.

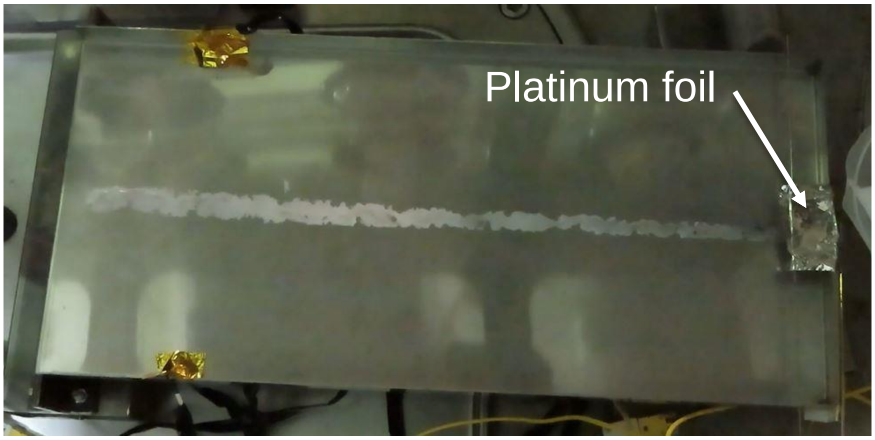

Figure 3: Image of stainless steel sheet that shows the position of the platinum foil for condensation collection.

Table 20: Composition of condensate collected on platinum foil above salt pool in Test 4

Test	Method[b]	Li (µg)	Na (µg)	K (µg)	Cs (µg)	I (µg)
Control[c]	Water	0.31	5.29	< 7.69	0.08	< 0.25
	Acid	0.08	0.36	< 3.91	0.26	–
	Combined	0.39	5.65	BDL	0.34	–
Sample	Water	1.09	11.00	12.6	1.61	< 0.31
	Acid	0.15	0.19	< 3.91	0.09	–
	Combined	1.24	11.19	12.6	1.70	–

[a] The number following the < is the detection limit.
[b] The foils were first leached with water and then leached a second time with acid. The composition in both the water and acid leachate is provided.
[c] The control foil was exposed to the glovebox atmosphere for approximately one hour.

3 Molten salt flowing and freezing behavior through tubing

The data provided in this section correspond to Section 4 in Thomas and Jackson, 2021, and the experimental design and methods are described therein. Table 21 provides a summary of the conditions of each test conducted to study FLiNaK flowing and freezing in stainless steel tubing.

Table 21: Summary of test conditions to study molten FLiNaK flowing through tubing[a]

Test	Target initial salt temp. (°C)[b]	Max salt temp. (°C)[c]	Avg. pour rate ($g\ s^{-1}$)	Tube inner diameter (in.)
1	675	660	14.8	¼
2	675	660	16.4	3⁄16
3	525	490	18.3	3⁄16
4	800	775	10.7	3⁄16

[a] All tests were performed with a pour mass of 25 g.
[b] The actual salt temperatures may have slightly differed from the target temperature.
[c] The maximum temperature of the salt measured by the IR camera (uncorrected for emissivity) provided an estimate of the actual salt temperature as it was poured.

3.1 Visible video from tests of molten salt flowing on stainless steel funnel cone

Visible video of the molten salt flowing on the stainless steel funnel cone and draining into the stainless steel tubing was filmed using a visible camera mounted on a tripod and is available upon reasonable request. A list of available videos is provided in Table 22.

Table 22: List of available visible video of flowing tests

Test	Filename
1	FunnelVideo_Test1.mp4
2	FunnelVideo_Test2.mp4
3	FunnelVideo_Test3.mp4
4	FunnelVideo_Test4.mp4

3.2 Temperature measurement of the stainless steel tubing

Frames from the processed IR video of the outer tube temperature were exported to .csv files at a rate of five frames per second and details on the available frames is provided in Table 23. The data processing technique to correct for the emissivity of the outer tube surface is described in Section 4.1.2.3 of Thomas and Jackson, 2021. The video frames were cropped to only include the region of the camera field of view that shows the funnel tube. Some background is also included in the field of view, but the background is distinguished from the tube by its much lower temperature in comparison with the outer tube surface temperature. It should be noted that the funnel tube may have moved slightly throughout the test duration and careful attention should be paid to the position of the tube. A time stamp file is also available for each test to provide the time that the frame was collected after the salt was poured.

Table 23: Information on exported IR video frames from flowing tests

Test	Number of frames	Total duration (s)
1	790	131.5
2	532	88.5
3	637	106.0
4	648	107.8

3.3 Temperature of the underside of the stainless steel beaker

The temperature of the underside of the stainless steel beaker that collected the molten salt that passed through the funnel tube was recorded with thermocouples attached to the underside surface and the results for each test are provided in Table 24. A description of the temperature measurement method and its performance is presented in Appendix B of Thomas and Jackson, 2021.

Table 24: Temp. (°C) measured by thermocouple attached to underside of stainless steel beaker

Time (min.)	Test			
	1	2	3	4
0.00	29.4	29.1	27.7	29.7
0.25	288.9	256.5	191.2	226.1
0.50	352.1	317.3	258.0	282.6
0.75	384.5	350.1	291.8	314.4
1.00	402.1	369.3	311.1	335.5
1.25	412.4	379.9	322.4	350.1
1.50	418.1	386.4	328.1	360.1
1.75	421.0	390.2	329.9	367.2
2.00	421.4	392.4	328.5	372.1
2.25	419.1	392.4	324.2	375.3
2.50	414.1	391.1	317.2	377.3
2.75	405.0	389.9	308.8	378.0
3.00	392.7	386.8	299.6	375.5
3.25	379.2	380.2	290.3	368.6
3.50	365.6	369.7	281.2	358.9
3.75	352.2	357.6	272.3	348.5
4.00	339.6	345.4	263.8	337.8

Table 24: (cont.)

Time (min.)	Test			
	1	2	3	4
4.25	327.7	333.5	255.5	327.1
4.50	316.3	322.0	247.5	316.7
4.75	305.5	310.9	239.9	306.5
5.00	295.2	300.5	232.6	296.8
5.25	285.3	290.5	225.5	287.6
5.50	276.0	281.0	218.8	278.7
5.75	267.1	271.9	212.3	270.0
6.00	258.7	263.2	206.2	261.8
6.25	250.6	254.8	200.3	253.9
6.50	242.8	246.9	194.7	246.2
6.75	235.5	239.3	189.2	239.0
7.00	228.5	232.1	184.0	232.0
7.25	221.9	225.1	179.1	225.3
7.50	215.5	218.5	174.3	218.9
7.75	209.3	212.2	169.7	212.7
8.00	203.5	206.1	165.4	206.8
8.25	197.9	200.2	161.2	201.2
8.50	192.5	194.6	157.1	195.8
8.75	187.4	189.3	153.3	190.6
9.00	182.5	184.2	149.6	185.7
9.25	177.8	179.4	146.0	180.9
9.50	173.4	174.7	142.5	176.3
9.75	169.0	170.2	139.2	171.9
10.00	164.8	165.9	135.9	167.7
10.25	160.9	161.8	132.8	163.6
10.50	157.0	157.8	129.8	159.7
10.75	153.3	154.0	126.9	155.9
11.00	149.7	150.4	124.0	152.3
11.25	146.3	146.8	121.3	148.8
11.50	143.0	143.4	118.7	145.4
11.75	139.7	140.1	116.2	142.1
12.00	136.7	137.0	113.7	138.9
12.25	133.7	133.9	111.4	135.9
12.50	130.8	130.9	109.1	132.9
12.75	128.0	128.0	106.9	130.1
13.00	125.3	125.3	104.8	127.3
13.25	122.6	122.6	102.7	124.6
13.50	120.1	120.0	100.7	122.0
13.75	117.6	117.5	98.8	119.5
14.00	115.3	115.1	96.9	117.1

Table 24: (cont.)

Time (min.)	Test			
	1	2	3	4
14.00	115.3	115.1	96.9	117.1
14.25	113.0	112.7	95.1	114.7
14.50	110.8	110.5	93.3	112.5
14.75	108.6	108.2	91.6	110.3
15.00	106.5	106.1	90.0	108.2
15.25	104.5	104.0	88.4	106.1
15.50	102.5	102.0	86.8	104.1
15.75	100.6	100.1	85.3	102.1
16.00	98.8	98.2	83.8	100.3
16.25	97.0	96.4	82.4	98.5
16.50	95.3	94.6	81.0	96.7
16.75	93.6	92.9	79.7	95.0
17.00	92.0	91.3	78.4	93.3
17.25	90.4	89.7	77.1	91.7
17.50	88.8	88.1	75.9	90.2
17.75	87.3	86.6	74.7	88.6
18.00	85.9	85.1	73.5	87.1
18.25	84.5	83.7	72.3	85.7
18.50	83.1	82.3	71.2	84.3
18.75	81.8	81.0	70.1	82.9
19.00	80.5	79.6	69.1	81.6
19.25	79.2	78.4	68.1	80.3
19.50	78.0	77.1	67.1	79.0
19.75	76.8	75.9	66.2	77.8
20.00	75.7	74.7	65.2	76.7
20.25	74.5	73.5	64.3	75.5
20.50	73.4	72.4	63.5	74.4
20.75	72.4	71.3	62.6	73.4
21.00	71.4	70.2	61.8	72.3
21.25	70.4	69.2	60.9	71.3
21.50	69.4	68.2	60.2	70.3
21.75	68.4	67.2	59.4	69.4
22.00	67.5	66.2	58.7	68.5
22.25	66.6	65.3	57.9	67.6
22.50	65.7	64.4	57.3	66.7
22.75	64.8	63.5	56.6	65.8
23.00	64.0	62.7	56.0	65.0
23.25	63.2	61.8	55.3	64.2
23.50	62.4	61.0	54.7	63.4
23.75	61.6	60.2	54.1	62.6

Table 24: (cont.)

Time (min.)	Test			
	1	2	3	4
24.00	60.8	59.5	53.5	61.9
24.25	60.1	58.7	52.9	61.1
24.50	59.4	58.0	52.3	60.4
24.75	58.7	57.3	51.8	59.7
25.00	58.0	56.6	51.3	59.0
25.25	57.4	55.9	50.8	58.4
25.50	56.7	55.3	50.2	57.7
25.75	56.1	54.6	49.7	57.1
26.00	55.5	54.0	49.2	56.5
26.25	54.9	53.5	48.7	55.9
26.50	54.4	52.9	48.2	55.3
26.75	53.8	52.3	47.7	54.7
27.00	53.3	51.8	47.2	54.2
27.25	52.7	51.3	46.7	53.6
27.50	52.2	50.7	46.2	53.1
27.75	51.7	50.2	45.8	52.6
28.00	51.2	49.7	45.4	52.1
28.25	50.8	49.2	45.0	51.6
28.50	50.0	48.7	44.7	51.1
28.75	48.9	48.3	44.3	50.7
29.00	47.9	47.9	43.9	50.2
29.25	46.9	47.4	43.5	49.7
29.50	46.0	47.0	43.1	49.2
29.75	45.2	46.6	42.8	48.7
30.00	44.4	46.2	42.4	48.3

The maximum temperature recorded at the beaker underside and the average thickness of the frozen salt pool in the beaker after it had cooled to room temperature are summarized in Table 25.

Table 25: The maximum temperature recorded at the beaker underside, the thickness of the frozen salt pool, and salt mass in beaker[a]

Test	Max. beaker underside temp. (°C)	Salt thickness (mm) [b]	Salt mass in beaker (g)
1	422	4.5 ± 0.6	21.6
2	393	5.6 ± 0.3	17.9
3	330	5.3 ± 0.2	17.1
4	378	5.0 ± 0.1	16.8

[a] The conditions of each test are provided in Table 21.
[b] Mean ± one standard deviation of three measurements.

3.4 Flow rate of salt through tubing

The flow rate of the salt through the tubing was determined by using a data logging scale that recorded the mass of the beaker at one-second intervals. The scale started to record once it detected a change from the tare weight. Table 26 reports the mass of salt in the stainless steel beaker as a function of time after the scale first detected a weight for the four tests in this section.

Table 26: The mass (g) of salt recorded in stainless steel beaker as a function of time

	Test			
Time (s)	1	2	3	4
0	2.0	10.1	5.8	5.7
1	14.2	18.1	10.9	15.7
2	20.4	18.2	14.4	16.8
3	20.9	18.1	15.3	17.0
4	21.1	18.1	15.9	17.0
5	21.0	18.1	16.2	17.0
6	21.0	18.1	16.4	16.9
7	20.9	18.1	16.5	16.9
8	20.9	18.1	16.5	16.9
9	20.9	18.1	16.5	16.9
10	20.9	18.1	16.5	16.9
11	20.9	18.1	16.5	16.9
12	20.9	18.1	16.5	16.9
13	20.9	18.1	16.5	16.9
14	20.9	18.0	16.5	16.9
15	20.9	18.0	16.5	16.9
16	20.9	18.0	16.5	16.9
17	20.9	18.0	16.5	16.9
18	20.9	18.0	16.5	16.9
19	21.0	18.0	16.5	16.8
20	21.0	18.0	16.5	16.8

3.5 Mass balance analysis

Table 27 presents the amounts of frozen salt that were recovered from the top of the funnel, from inside the tubing, from the stainless steel beaker below the tubing, and not recovered as a fraction of the total mass poured for the four tests conditions in this section.

Table 27: Results from mass balance analysis of frozen FLiNaK salt

Test	Mass poured (g)	Mass recovered from top (g)	Mass recovered from tube (g)	Mass recovered from beaker (g)	Total mass recovered (g)	Mass lost (g)
1	24.7	1.8	0.8	21.6	24.3	0.4
2	24.5	2.1	3.6	17.9	23.6	1.0
3	23.3	4.2	1.6	17.1	22.9	0.4
4	24.3	2.1	4.2	16.8	23.1	1.2

3.6 Glovebox conditions

The measured temperature, O_2 content, and H_2O content of the atmosphere of the argon atmosphere glovebox recorded before and after each test are provided in Table 28.

Table 28: The O_2 content, H_2O content, and temperature of the glovebox atmosphere measured before and after each test

	O_2 content (ppm)		H_2O content (ppm)		Temp. (°C) of atmosphere		
Test	Before	After	Before	After	Before	After	Max.
1	2	2	1	1	32	30	34
2	1	1	< 1	< 1	27	26	27
3	1	1	2	2	29	29	29
4	2	2	< 1	< 1	29	29	30

4 Stainless steel corrosion kinetics in molten salt

The data provided in this section correspond to Section 5 in Thomas and Jackson, 2021, and the experimental design and methods are described therein. Table 29 provides a summary of the electrochemical corrosion test conditions conducted with 316 stainless steel in molten FLiNaK.

Table 29: Summary of test conditions to study the corrosion of 316 stainless steel in molten FLiNaK

Test	Salt temp. (°C)	PD scan[a]	PS test[b]	PS hold potential (V above E_{CORR})
1	500	Y	Y	0.2
2	650	Y	N	n/a
3	800	Y	Y	0.1

[a] PD = Potentiodynamic
[b] PS = Potentiostatic

The files of the potentiodynamic (PD) scans of 316 stainless steel coupons in molten FLiNaK at temperatures of 500 °C, 650 °C, and 800 °C are available upon reasonable request. The PD scan consists of the stainless steel surface potential (V vs. Li/Li^+) that was measured as a function of current density (A cm^{-2}). The files of the potentiostatic (PS) tests are available upon reasonable request and consist of the current density (A cm^{-2}) measured as a function of time at fixed temperature and stainless steel surface potential. Table 30 provides a summary of the steady corrosion currents that were measured during PS tests at fixed temperature and surface potential and the mass corrosion rates and penetration rates that were calculated from the steady corrosion currents.

Table 30: Summary of steady corrosion currents measured during PS tests and calculated mass corrosion rates and penetration rates

Test	Salt temp. (°C)	PS hold potential (V vs. Li/Li^+)	PS hold potential (V above E_{CORR})	Steady current density (A cm^{-2})	Mass corrosion rate (g cm^{-2} d^{-1})	Penetration rate (mm yr^{-1})
1	500	1.64	0.2	1.8×10^{-4}	4.1×10^{-3}	1.9
3	800	1.40	0.1	1.8×10^{-4}	4.1×10^{-3}	1.9

5 Molten salt splashing and aerosol formation

The data provided in this section correspond to Section 6 in Thomas and Jackson, 2021, and the experimental design and methods are described therein. Table 31 provides a summary of the conditions of each FLiNaK splashing and aerosol generation test that was conducted. The conditions include the initial salt temperature; the average pour rate; the total mass of CsF, CsI, and FLiNaK added to the crucible prior to heating; and the mass that was poured into the spill containment box.

Table 31: Summary of splashing and aerosol generation test conditions for tests using molten FLiNaK with surrogate fission products[a]

Test	Initial salt temp. (°C) estimate[b]	Avg. pour rate (g s^{-1})	Mass CsF (g)	Mass CsI (g)	Mass FLiNaK (g)	Mass poured (g)[c]
1	500	18.4	0.51	0.10	14.45	14.15
2	500	14.8	0.50	0.11	14.48	13.81
3	650	19.6	0.48	0.09	14.44	14.52
4	650	19.9	0.50	0.10	14.44	13.96
5	800	21.2	0.49	0.11	14.45	14.66
6	800	15.5	0.51	0.11	14.43	14.74
7	800	16.9	–	–	15.08	14.86

[a] The pour height was 15 in. for all tests.
[b] The initial salt temperature was estimated by a thermocouple placed in the furnace liner in which the salt was heated.
[c] The mass poured is equal to the mass of salt added to the crucible minus the mass of salt that remained in the crucible after pouring.

5.1 Video of splashing and mist formation

Visible video of molten salt pouring and splashing into the spill containment box was filmed through a view port on the ceiling of the box using a visible camera that was mounted on a tripod. The visible video was filmed at 240 frames per second and real time and slow motion (20x slowed down) video of the splashing is available upon reasonable request. Visible video of mist floating above the molten salt pool in the spill containment box is also available for some tests. A list of available videos is provided in Table 32.

Table 32: List of available visible video of molten salt splashing tests

Test	Video Description	Filename
1	Splash video – real time	SplashingVideo_Test1.mp4
	Splash video – 20x slow	SplashingVideo_Test1_slowmo.mp4
2	Splash video – real time	SplashingVideo_Test2.mp4
	Splash video – 20x slow	SplashingVideo_Test2_slowmo.mp4
3	Splash video – real time	SplashingVideo_Test3.mp4
	Splash video – 20x slow	SplashingVideo_Test3_slowmo.mp4
	Mist video – real time	SplashingVideo_Test3_mist.mp4
4	Splash video – real time	SplashingVideo_Test4.mp4
	Splash video – 20x slow	SplashingVideo_Test4_slowmo.mp4
5	Splash video – real time	SplashingVideo_Test5.mp4
	Splash video – 20x slow	SplashingVideo_Test5_slowmo.mp4
	Mist video – real time	SplashingVideo_Test5_mist.mp4
6	Splash video – real time	SplashingVideo_Test6.mp4
	Splash video – 20x slow	SplashingVideo_Test6_slowmo.mp4
	Mist video – real time	SplashingVideo_Test6_mist.mp4
7	Splash video – real time	SplashingVideo_Test7.mp4
	Splash video – 20x slow	SplashingVideo_Test7_slowmo.mp4

5.2 Particle abundance and size distribution on coupons

Coupons with dimensions of 1 in. × 1 in. were hung on the walls of the catch pan surrounding the spill zone and on the wall furthest from the spill zone just below the aerosol collection filter to collect splatter for the determination of particle abundance and size distribution. The locations and labels of the coupons are shown in Figure 4.

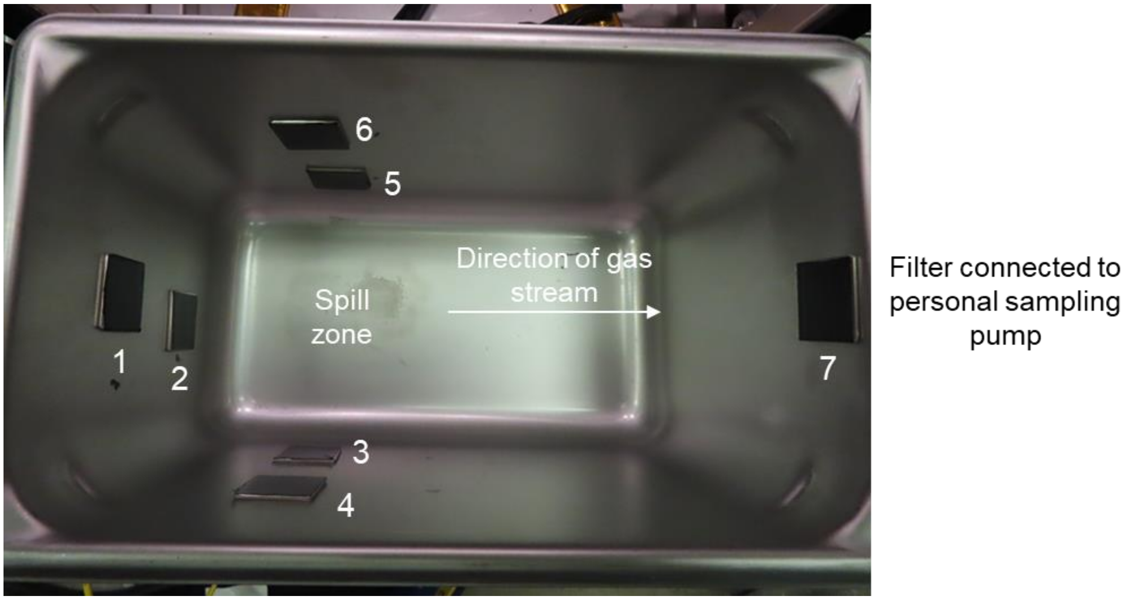

Figure 4: The coupon labels and locations in the catch pan relative to the salt spill zone. The filter for aerosol collection is positioned directly above Coupon 7 on the far wall from the spill zone.

Raw visible images of the coupons collected after the splash tests are available upon reasonable request. The splatter particle areas (2-dimensional projection) were determined from the processed images for each coupon as described in Section 6.1.2.7 in Thomas and Jackson, 2021 and the processed images and particle size data are available upon reasonable request. The total area analyzed for each coupon of each test is provided in Table 33.

Table 33: Summary of total area (mm^2) analyzed per coupon for each test

	Coupon						
Test	1	2	3	4	5	6	7
1	424.5	332.0	399.7	158.8	295.5	516.2	392.9
2	468.3	312.1	410.9	385.4	436.2	445.2	412.0
3	514.8	342.6	457.5	469.1	558.6	168.7	354.7
4	–	–	355.0	421.6	487.9	454.1	337.3
5	552.2	503.3	491.7	405.8	360.0	494.7	445.1
6	155.7	147.7	474.3	377.7	382.6	387.9	536.4
7	286.0	567.6	574.3	407.2	573.6	451.1	426.9

5.3 Splatter quantification by mass fraction

The total mass of salt, the mass of salt that formed a pool, and the mass of salt that formed splatter that was recovered from the catch pan after freezing is provided in Table 34. The mass fraction of salt that was not recovered was determined from the difference between the mass of salt poured and the total mass of salt that was recovered.

Table 34: Mass balance results of salt recovered from catch pan after freezing

Test	Total mass recovered (g)	Mass of pooled salt (g)	Mass of splatter (g)	Mass not recovered (g)
1	13.98	10.84	3.13	0.17
2	13.61	10.67	2.94	0.20
3	14.25	11.48	2.77	0.27
4	13.78	11.15	2.63	0.19
5	14.36	11.75	2.61	0.30
6	14.45	12.10	2.35	0.29
7	14.59	12.03	2.56	0.27

5.4 Aerosol collection on filters

Aerosol cassettes with 0.45-µm-pore size PTFE filters were used to sample the spill containment box atmosphere for suspended particulates using the methods described in Section 6.1.2.6 in Thomas and Jackson, 2021. The composition of collected particulates on the filters was analyzed as described in Section 2.3 of Thomas and Jackson, 2021 and the results are provided in Table 35. The filters were rinsed a second time with acid and the acid leachate was analyzed for total lithium, sodium, potassium, and cesium (Table 36).

Table 35: Elemental composition of particulates collected on 0.45-µm filters measured in water leachate[a,b]

Test[c]	Target initial temp. (°C)	Sampling time (sec)	CsF & CsI in salt?	Li (µg)	Na (µg)	K (µg)	Cs (µg)	I (µg)
Blank[d]	n/a	561	n/a	< 0.12	0.63	< 0.48	< 0.002	< 0.02
Control[e]	n/a	553	n/a	< 0.01	1.74	< 0.55	0.01	< 0.03
1	500	573	Yes	< 0.01	1.30	0.65	0.12	< 0.03
2	500	558	Yes	< 0.12	40.5	< 0.48	0.14	< 0.02
3	650	524	Yes	< 0.01	2.29	1.97	0.41	< 0.03
4	650	561	Yes	< 0.12	0.88	< 0.48	0.33	< 0.05
5	800	553	Yes	< 0.01	1.45	1.44	1.76	0.15
7	800	540	No	< 0.01	1.82	1.40	0.01	< 0.03

[a] The number following the < is the detection limit.
[b] The total mass of particulates collected on the filter was too small to measure.
[c] A filter measurement was not conducted for Test 6 at an initial salt target temperature of 800 °C because aerosols were collected using cascade impactors instead.
[d] The composition of the blank filter was measured directly after removal from its packaging.
[e] The control filter sampled the background glovebox atmosphere for 10 minutes before any FLiNaK splash tests were conducted.

Table 36: Elemental composition of particulates collected on 0.45-μm filters after acid leach[a,b]

Test[c]	Target initial temp. (°C)	CsF & CsI in salt?	Li (μg)	Na (μg)	K (μg)	Cs (μg)
Blank	n/a	n/a	0.29	0.21	< 1.96	< 0.004
Control	n/a	n/a	0.14	0.07	< 1.96	0.01
1	500	Yes	0.13	0.12	<1.96	<0.008
2	500	Yes	0.22	0.10	< 1.96	0.03
3	650	Yes	0.22	0.11	<1.96	0.05
4	650	Yes	0.16	0.07	< 1.96	0.02
5	800	Yes	0.14	0.04	<1.96	0.02
7	800	No	0.13	0.07	<1.96	<0.004

[a] The number following the < is the detection limit.
[b] Iodine was not quantified in the acid leachate solution.
[c] A filter measurement was not conducted for Test 6 at an initial salt target temperature of 800 °C because aerosols were collected using cascade impactors instead.

5.5 Temperatures measured in the spill containment box

The temperature of the catch pan underside beneath the salt spill zone (see Figure 4) is provided as a function of time after spilling the salt for each test in Table 37.

Table 37: Temp. (°C) measured by thermocouple attached to underside of stainless steel catch pan

Time (min.)	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
0.00	26.5	25.2	26.4	25.1	29.2	25.0	27.8
0.25	54.4	37.6	90.9	71.2	163.1	147.2	135.9
0.50	80.7	53.7	150.3	113.6	241.4	234.5	209.0
0.75	100.2	68.2	191.9	140.9	272.0	287.1	251.3
1.00	113.0	79.6	218.8	156.8	280.5	309.8	273.9
1.25	120.2	87.5	233.6	165.6	278.4	312.2	284.1
1.50	123.2	92.7	239.9	169.8	270.7	305.3	286.1
1.75	123.4	95.8	240.8	171.0	260.3	293.5	282.2
2.00	122.2	97.4	237.8	170.0	248.7	279.9	274.6
2.25	120.1	97.8	232.2	167.4	236.9	265.6	265.1
2.50	117.4	97.4	224.7	163.6	225.2	251.3	254.5
2.75	114.4	96.4	216.3	158.9	213.9	237.6	243.4
3.00	111.3	95.0	207.4	153.8	203.0	224.6	232.5
3.25	108.1	93.2	198.2	148.3	192.7	212.3	221.8
3.50	104.9	91.2	189.1	142.7	183.0	200.8	211.4
3.75	101.7	89.0	180.3	137.0	173.9	190.1	201.5
4.00	98.5	86.8	171.9	131.4	165.4	180.2	192.0
4.25	95.4	84.6	163.8	125.9	157.6	171.0	183.1
4.50	92.3	82.4	156.1	120.6	150.2	162.4	174.7
4.75	89.4	80.2	148.9	115.5	143.3	154.5	166.7
5.00	86.6	77.9	141.9	110.7	136.8	147.0	159.2

Table 24: (cont.)

Time (min.)	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7
5.25	83.9	75.8	135.2	106.1	130.8	140.0	152.3
5.50	81.3	73.7	128.8	101.8	125.1	133.5	145.7
5.75	78.9	71.7	123.0	97.7	119.9	127.4	139.5
6.00	76.5	69.7	117.4	93.8	114.9	121.7	133.7
6.25	74.2	67.8	112.3	90.2	110.3	116.4	128.2
6.50	72.1	66.0	107.5	86.8	106.0	111.5	123.0
6.75	69.9	64.2	103.0	83.5	102.1	106.8	118.2
7.00	67.9	62.5	98.9	80.5	98.3	102.5	113.7
7.25	66.0	60.9	95.0	77.5	94.6	98.5	109.3
7.50	64.2	59.4	91.3	74.7	91.3	94.7	105.3
7.75	62.5	57.9	87.9	72.1	88.2	91.1	101.5
8.00	60.8	56.5	84.7	69.6	85.2	87.8	97.9
8.25	59.3	55.1	81.6	67.2	82.4	84.6	94.6
8.50	57.8	53.8	78.8	65.0	79.8	81.7	91.4
8.75	56.4	52.6	76.2	62.9	77.4	79.0	88.4
9.00	55.1	51.5	73.7	61.0	75.0	76.4	85.6
9.25	53.8	50.3	71.4	59.2	72.9	73.9	83.0
9.50	52.6	49.3	69.1	57.5	70.8	71.6	80.4
9.75	51.5	48.2	67.1	55.9	68.9	69.5	78.0
10.00	50.4	47.3	65.1	54.4	67.0	67.4	75.8

The temperatures of various locations within the spill containment box atmosphere are provided as a function of time after spilling the salt in Table 38, Table 39, Table 40, Table 41, Table 42, Table 43, and Table 44 for Tests 1, 2, 3, 4, 5, 6, and 7, respectively. The locations of thermocouples TC2, TC3, and TC4 measuring the temperatures of the spill containment box atmosphere are shown in Figure 5.

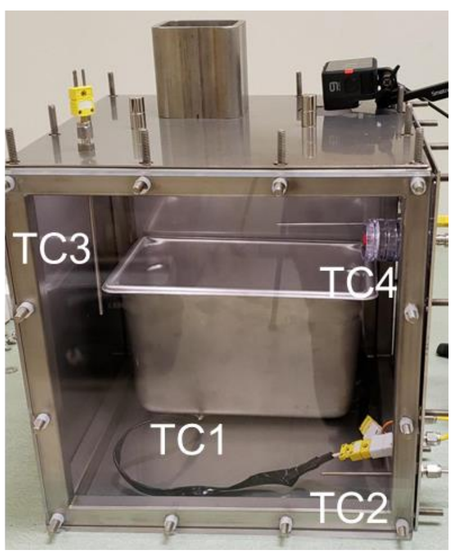

Figure 5: The locations of thermocouples TC2, TC3, and TC4 that measured the temperature of the spill containment box atmosphere. TC1 is the thermocouple that measured the temperature of the catch pan underside.

Table 38: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 1

Time (min.)	TC2	TC3	TC4
0.0	28.0	29.7	27.2
0.5	28.2	30.1	28.6
1.0	28.5	30.6	29.8
1.5	28.7	31.0	30.5
2.0	28.9	31.4	31.0
2.5	29.1	31.7	31.3
3.0	29.2	32.0	31.5
3.5	29.4	32.2	31.5
4.0	29.5	32.4	31.5
4.5	29.5	32.5	31.5
5.0	29.6	32.7	31.4
5.5	29.6	32.8	31.3
6.0	29.7	32.9	31.2
6.5	29.7	33.0	31.1
7.0	29.7	33.0	31.0
7.5	29.7	33.1	30.8
8.0	29.7	33.1	30.7
8.5	29.8	33.2	30.6
9.0	29.8	33.2	30.5
9.5	29.7	33.2	30.4
10.0	29.7	33.2	30.2

Table 39: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 2

Time (min.)	TC2	TC3	TC4
0.0	26.6	28.6	26.0
0.5	26.7	29.5	27.6
1.0	26.9	30.1	28.6
1.5	27.1	30.4	29.1
2.0	27.3	30.7	29.2
2.5	27.4	31.0	29.3
3.0	27.5	31.2	29.2
3.5	27.7	31.3	29.1
4.0	27.8	31.5	29.0
4.5	27.9	31.6	28.9
5.0	28.0	31.8	28.8
5.5	28.1	31.8	28.7
6.0	28.1	31.9	28.6
6.5	28.2	31.9	28.6
7.0	28.2	31.9	28.5
7.5	28.3	32.0	28.4
8.0	28.3	31.9	28.3
8.5	28.3	31.9	28.3
9.0	28.4	31.9	28.2
9.5	28.4	31.9	28.1
10.0	28.3	31.9	28.1

Table 40: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 3

Time (min.)	TC2	TC3	TC4
0.0	27.6	29.7	27.0
0.5	27.7	30.2	28.2
1.0	27.9	30.7	29.4
1.5	28.1	31.3	30.3
2.0	28.3	31.7	30.9
2.5	28.5	32.1	31.3
3.0	28.6	32.4	31.5
3.5	28.7	32.7	31.7
4.0	28.8	32.9	31.7
4.5	28.9	33.1	31.7
5.0	29.0	33.3	31.7
5.5	29.1	33.5	31.6
6.0	29.2	33.6	31.5
6.5	29.3	33.7	31.4
7.0	29.4	33.8	31.3
7.5	29.4	33.8	31.1
8.0	29.5	33.9	31.0
8.5	29.5	33.9	31.0
9.0	29.5	33.9	30.9
9.5	29.6	33.9	30.8
10.0	29.6	33.9	30.7

Table 41: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 4

Time (min.)	TC2	TC3	TC4
0.0	26.5	28.8	25.9
0.5	26.7	29.4	27.6
1.0	27.0	30.1	28.9
1.5	27.2	30.6	29.7
2.0	27.4	31.1	30.1
2.5	27.6	31.5	30.2
3.0	27.8	31.8	30.2
3.5	27.9	32.2	30.2
4.0	28.0	32.4	30.1
4.5	28.2	32.6	30.0
5.0	28.3	32.8	30.0
5.5	28.3	32.9	29.9
6.0	28.4	33.0	29.8
6.5	28.5	33.1	29.7
7.0	28.5	33.1	29.6
7.5	28.6	33.2	29.5
8.0	28.6	33.2	29.4
8.5	28.6	33.2	29.3
9.0	28.6	33.2	29.3
9.5	28.7	33.2	29.2
10.0	28.7	33.1	29.1

Table 42: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 5

Time (min.)	TC2	TC3	TC4
0.0	29.2	31.6	28.8
0.5	29.5	32.2	30.6
1.0	29.8	32.8	31.8
1.5	30.1	33.4	32.8
2.0	30.4	34.0	33.5
2.5	30.6	34.5	33.9
3.0	30.8	35.0	34.2
3.5	31.0	35.4	34.3
4.0	31.1	35.7	34.3
4.5	31.3	36.0	34.3
5.0	31.4	36.3	34.2
5.5	31.4	36.5	34.1
6.0	31.5	36.7	34.0
6.5	31.6	36.8	33.8
7.0	31.7	37.0	33.8
7.5	31.7	37.0	33.6
8.0	31.7	37.1	33.5
8.5	31.7	37.1	33.4
9.0	31.8	37.1	33.3
9.5	31.8	37.2	33.2
10.0	31.8	37.2	33.1

Table 43: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 6

Time (min.)	TC2	TC3	TC4
0.0	26.3	28.5	25.8
0.5	26.6	29.0	27.5
1.0	26.9	29.6	29.0
1.5	27.2	30.1	30.1
2.0	27.5	30.7	30.9
2.5	27.8	31.1	31.4
3.0	28.0	31.5	31.6
3.5	28.3	31.9	31.8
4.0	28.5	32.2	31.8
4.5	28.6	32.4	31.8
5.0	28.8	32.7	31.8
5.5	28.9	32.8	31.7
6.0	29.0	33.0	31.6
6.5	29.1	33.1	31.5
7.0	29.3	33.2	31.4
7.5	29.3	33.3	31.3
8.0	29.4	33.3	31.2
8.5	29.4	33.4	31.1
9.0	29.5	33.5	31.0
9.5	29.5	33.4	30.9
10.0	29.6	33.5	30.8

Table 44: The temp. (°C) of the spill containment box atmosphere by thermocouple for Test 7

Time (min.)	TC2	TC3	TC4
0.0	29.3	31.5	29.0
0.5	29.6	32.2	30.8
1.0	29.9	33.0	32.0
1.5	30.2	33.7	32.7
2.0	30.4	34.3	33.1
2.5	30.7	34.8	33.4
3.0	30.9	35.3	33.5
3.5	31.1	35.8	33.6
4.0	31.3	36.2	33.6
4.5	31.4	36.5	33.6
5.0	31.5	36.8	33.5
5.5	31.6	37.0	33.4
6.0	31.7	37.1	33.4
6.5	31.8	37.3	33.3
7.0	31.9	37.4	33.2
7.5	31.9	37.5	33.1
8.0	32.0	37.5	33.1
8.5	32.0	37.5	33.0
9.0	32.0	37.6	32.9
9.5	32.1	37.6	32.9
10.0	32.1	37.6	32.8

5.6 Glovebox conditions

The O_2 content and H_2O content of the argon atmosphere glovebox was recorded before and after each test and is provided in Table 45. The temperature of various locations within the spill containment box atmosphere was recorded throughout the duration of the tests and is discussed in Section 5.5.

Table 45: The O_2 content and H_2O content of the glovebox atmosphere measured before and after each test

	O_2 content (ppm)		H_2O content (ppm)	
Test	Before	After	Before	After
1	< 1	< 1	5	5
2	< 1	< 1	4	4
3	28	28	< 1	< 1
4	< 1	< 1	1.5	1.5
5	< 1	< 1	4	4
6	1	1	< 1	< 1
7	1.5	1.5	2	2

5.7 Salt composition analysis by ICP-MS

Table 46 provides the concentration of major cations (lithium, sodium, potassium, and cesium) and iodine and Table 47 provides the concentration of trace metals that were measured in the salt after splashing for each test. The samples from each test were taken from the salt that pooled at the bottom of the catch pan (pool) and the splatter particles that dispersed within the catch pan (splatter). The measurement methods are described in Section 2.3 in Thomas and Jackson, 2021.

Table 46: Composition of frozen salt samples collected from splash tests[a]

Test	Target initial temp. (°C)	CsF & CsI in salt?	Sample type	LiF (mol %)	NaF (mol %)	KF (mol %)	CsF (mol %)	CsI[a] (mol %)
1	500	Yes	Splatter	48.40	11.27	39.28	0.97	0.09
			Pool	48.63	11.26	39.12	0.91	0.08
2	500	Yes	Splatter	44.94	11.55	42.58	0.84	0.10
			Pool	46.39	11.48	41.25	0.79	0.08
3	650	Yes	Splatter	47.72	11.54	39.67	0.98	0.09
			Pool	48.49	11.32	39.18	0.92	0.09
4	650	Yes	Splatter	46.06	11.68	41.26	0.88	0.12
			Pool	45.18	11.87	42.01	0.82	0.11
5	800	Yes	Splatter	47.22	11.72	40.05	0.89	0.12
			Pool	48.78	11.25	38.97	0.88	0.12
6	800	Yes	Splatter	46.02	11.17	41.78	0.92	0.11
			Pool	46.37	11.26	41.39	0.87	0.11
7	800	No	Splatter	50.6	11.0	38.5	n/a	n/a
			Pool	49.3	11.3	39.4	n/a	n/a

[a] Mol % of CsI was calculated assuming all detected iodine was present as CsI.

Table 47: Trace metal composition of frozen salt samples collected from splash tests[a,b]

Test	Target initial temp. (°C)	CsF & CsI in salt?	Sample type	Ca (ppm)	Cr (ppm)	Mn (ppm)	Ni (ppm)	Rb (ppm)	Cs[c] (ppm)
1	500	Yes	Splatter	<203	<1.52	1.31	41.7	24.6	–
			Pool	<127	13.3	1.57	28.7	25.0	–
2	500	Yes	Splatter	373	<1.27	<1.30	47.9	25.3	–
			Pool	577	<1.37	3.03	26.1	24.6	–
3	650	Yes	Splatter	<581	<1.83	2.77	177	24.6	–
			Pool	<656	<1.81	6.87	8.05	24.7	–
4	650	Yes	Splatter	418	6.20	2.39	96.5	24.6	–
			Pool	517	<1.19	2.18	52.5	23.5	–
5	800	Yes	Splatter	<488	<1.66	32.9	24.3	23.3	–
			Pool	<635	<1.93	4.49	26.1	24.3	–
6	800	Yes	Splatter	<186	2.78	2.86	24.3	25.4	–
			Pool	648	2.83	3.73	22.6	25.1	–
7	800	No	Splatter	<104	<2.09	4.50	<0.54	25.4	38.9
			Pool	<635	<1.86	6.08	<0.66	23.8	13.2

[a] The concentration of Fe in all samples was below the detection limit of approximately 70 ppm.
[b] The number after < is the detection limit.
[c] The Cs concentration of FLiNaK doped with CsF and CsI is reported in Table 46.

5.8 Composition of condensation on ceiling of spill containment box

The ceiling of the spill containment box was wiped with a methanol-soaked glass fiber filter and analyzed for total lithium, sodium, potassium, cesium, and iodine by using ICP-MS as described in Section 6.2.6 in Thomas and Jackson, 2021. The results from the first leach of the wipe with water are provided in Table 48 and the results from the second leach of the wipe in acid are provided in Table 49. The fact that a significant amount of sodium and potassium are acid-leached from the glass fiber filters of the blank and control indicate that acid leaching is not compatible with the filter material.

Table 48: Elemental composition of wipe sample from ceiling of spill containment box measured after first leach with water[a]

Test	Li (µg)	Na (µg)	K (µg)	Cs (µg)	I (µg)
Blank[b]	< 0.14	166	7.6	< 0.003	< 0.03
Control[c]	< 0.16	174	9.7	0.05	0.17
Sample	2.00	102	10.6	0.23	0.13

[a] The number following the < is the detection limit.
[b] The Blank was a wipe that was removed from its packaging and directly analyzed.
[c] The Control was a wipe that was soaked in methanol and then analyzed.

Table 49: Elemental composition of wipe sample from ceiling of spill containment box measured after second leach with acid[a,b]

Test	Li (µg)	Na (µg)	K (µg)	Cs (µg)
Blank[c]	1.50	5760	2150	0.23
Control[d]	1.67	5520	2120	2.51
Sample	1.50	2850	1090	4.18

[a] The number following the < is the detection limit.
[b] Iodine was not quantified in the acid leachate solution.
[c] The Blank was a wipe that was removed from its packaging and directly analyzed.
[d] The Control was a wipe that was soaked in methanol and then analyzed.

5.9 Splatter and aerosol particle composition by SEM-EDS

Splatter that was collected on coupons was analyzed using scanning electron microscopy (SEM) with associated energy dispersive X-ray spectroscopy (EDS), and a description of select SEM micrographs, EDS emission maps, EDS line scans, and EDS spectra are described in Section 6.2.7 of Thomas and Jackson, 2021. Additional SEM micrographs and data from EDS analysis is available from the authors upon reasonable request.

References

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